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THE FULLER ELECTRICAL COMPANY.

What Engineering Skill and Legitimate Business Methods may Accomplish.

A COMPLETE SYSTEM OF ELECTRIC LIGHTING—EFFICIENCY, AND ECONOMY OF THE SYSTEM—THE GRAMME ELECTRO-DYNAMIC MACHINE—MR. FULLER WORKS OUT A LIGHTING PROBLEM IN THE ROUGH—SINGLE AND DUPLEX LAMPS—STREET-LAMP—GENERATOR—MOTOR—MARINE REFLECTOR—STANDARD FOR GENERATOR—TABLE OF COMPUTATIONS—SEMI-INCANDESCENT LAMP—THE DEFECTS OF THE EARLIER LAMPS—THE VARIOUS SYSTEMS—THE ADVANTAGES OF THE CLOCK-FEED SYSTEM—THE LOCOMOTIVE ELECTRICAL HEAD-LIGHT—THE ADVANTAGES OF ELECTRICAL ILLUMINATION.

It is the aim of the New York ELECTRICAL REVIEW to place before its readers at the earliest possible moment whatever of real importance there may, from time to time, appear in the electrical field.

Following this policy, we herewith present a full and complete description of the Fuller Electrical Company's system of arc-lighting; than which, it may be said without the fear of contradiction, a more thorough, complete and reliable means of electric lighting does not exist either in this country or in Europe.

The admirable mechanism adopted by the Fuller Company in the construction of its machines, lamps, and apparatus, and illustrated in this number, is founded upon a correct interpretation of natural laws. It was designed by the company's electrician, Mr. James J. Wood, a gentleman possessing rare genius in this field of Electrical Science.

Before taking up the technical consideration of the Fuller Company's system, it might, perhaps, not be found uninteresting to look for a moment at the means which that company has employed to introduce its system; and as many companies are now forming for the exploitation of various electrical systems, their officers may, perhaps, find the perusal of their explanation a not wholly unprofitable occupation.

Exaggeration would seem to have had no part in the methods of the Fuller Company. For this reason, its steps into popular favor, while perhaps slower than some of its rivals, have been surer. Never promising more than they could perform, its officers have not had the mortification of being confronted with practical refutations of their own statements. Only that has been promised for the plant, which it has given positive evidence of an ability to perform. Those who have used the Fuller Company's lights are its best friends.

The reliability of the Gramme dynamo-electric machine, upon which the Fuller system may be said to be based, is well known. The currents from this machine are absolutely equal, so that they neither decompose water nor affect a tangent galvanometer interposed in the circuit.

An authority says that when one or more electric lamps are in the circuit, this equality is still unaltered, provided the two carbons are alike, similarly arranged and equally heated. If the carbons are unequal in size, then that current of the machine prevails which passes from the larger to the smaller carbon, *i.e.*, from the less heated to the more heated. Between a large mass of carbon or a mass of metal, on the one hand, and a carbon point on the other, the phenomenon attains a maximum; the intensity of the differential current is found to be equal to the following numbers of Bunsen cells: With iron, 3.2; with retort coke, 5.0; with copper, 50.6; with mercury, 103.7.

As the resistance of the arc is independent of the direction of the current, the latter cannot be the cause of the differential current. The carbon mercury burner, in fact, changes the action of the machine, for one set of currents is abolished, or at least greatly weakened, and the other set is formed by successive currents of greater intensity and duration. An electric arc lamp introduced into such a circuit acts in the same way as if it were worked with a battery current, *i.e.*, there is greater heat at the positive pole and transference of matter to the negative pole. The machine, moreover, before incapable of decomposing water, now acts as energetically as a pile of one hundred Bunsen elements; similarly other chemical actions, the magnetization of soft iron, the reduction of metals, etc., can be effected by it as by a machine with constant currents.

This much for the theory.

In practice, the generator adopted for this company, in the model, electrically, of the Gramme machine, is especially adapted for economical and efficient arc-lighting. It is reliable and smooth running, and the lights are constant and steady.

The use of electric lights, of the type known as "arc," is now generally recognized as the most economical, as well as the most effective, method of illuminating all large spaces, whether in the open air or in enclosures and buildings. The Fuller Company was one of the first to undertake the development of this business, and its efforts have been constantly directed toward applying this illuminant to every purpose for which it is adapted, and to the perfection of the numerous details which go to make up a complete system. This company has also done much toward removing the various objections to the use of a light of so great illuminating power, which have naturally enough presented themselves, and which have been chiefly suggested by motives of interest, prejudice, or unwillingness to adopt a plan of lighting, involving so wide a departure from all previous methods, and respecting which unnecessary apprehensions have been excited, as to want of permanence, dangers to person and property, injury to sight, etc. It is now a fact, well recognized by insurance companies, by a great number of users of electric lights, and many others who have made exhaustive examinations of the subject, that there is less danger of fire resulting from the use of a properly constructed electric lighting system than from any other known illuminant; and other objections, so often heard in the early days of its use, no longer form an obstacle to its increasing usefulness.

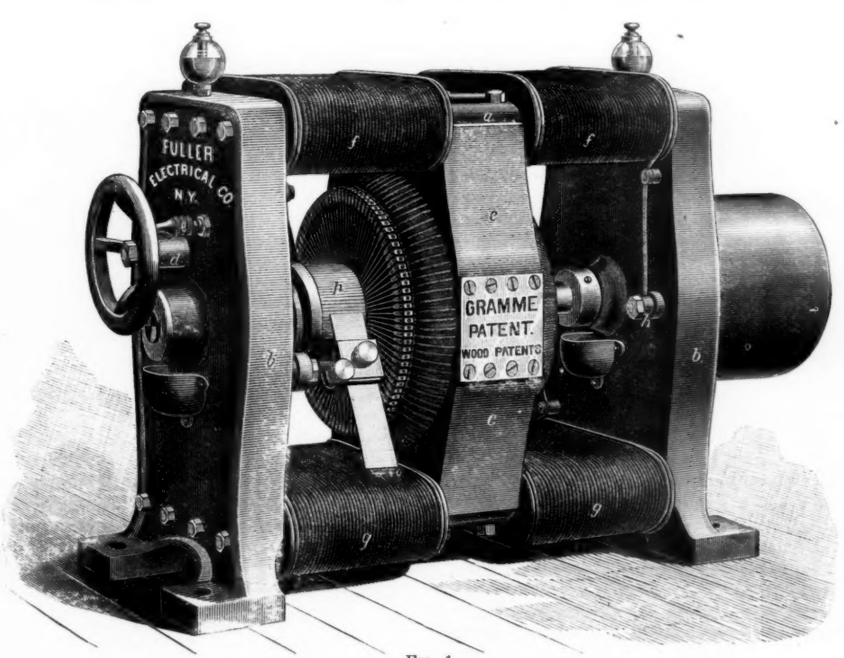


FIG. 1.

It has for many years past been known to scientists that a powerful and brilliant light could be produced by electricity; but that any means would ever be discovered by which a sufficient current could be produced to accomplish such a result economically, and to so govern it as to enable many lights to be operated in series, upon a single circuit, seemed improbable.

Immediately following the discoveries of Faraday and others, from 1830 to 1840, there was a widespread effort to make practical use of them, and special activity was manifested in the line of electric lighting. The arc light was put into practical form, and the foundations of incandescence lighting were laid. But no economic source of electricity was at hand, for the galvanic battery consumed too much zinc for profit.

The principle of the magneto-electric machine had, indeed, been long known; but it was left for the Italian Pacinnotti, in 1850, to devise a machine wherein continuous and constant currents were generated. This idea was put in practical operation by Gramme in 1870.

Mr. J. B. Fuller, of Brooklyn, N. Y., was one of the first electricians to perceive the possibilities for a practical scheme of lighting, and he set for himself the task of overcoming the obstacles which stood in the path of success.

After some years of labor, he produced and patented numerous inventions for the application of electric currents to telegraphy, motive power, electro-plating, and other useful purposes; and for the perfecting and introducing into practical use of these inventions "The Fuller Electrical Company" was incorporated in 1878. In the following year Mr. Fuller died, leaving his plans comparatively undeveloped, and some of his inventions unperfected. The company, however, had advanced so far as to feel certain of the realization of practical and useful results; and, availing itself of the service of able electricians and skillful mechanics, foremost among whom were Mr. James J. Wood and Mr. James Brady, has produced a dynamo-electric machine which satisfies the severest tests to which such machines can be subjected, and a series of lamps, each adapted to its own special purpose, together with appliances for governing and operating the same, to which it invites the attention of scientists, electricians, and mechanics, as well as all who now use, or contemplate using, electrical apparatus for lighting purposes.

The electric light is superior to any other light where it is necessary to distinguish colors, as in paper mills, silk factories, dry-goods stores, &c. It has been used with great advantage for the bleaching of sugars, and it is superior to every other light in respect to healthfulness. A single gas jet is estimated to consume the same amount of oxygen from the air as is required for the respiration of a single person. The electric light does not affect the life-sustaining properties of the atmosphere, nor increase the temperature of the room or space lighted by it appreciably. It therefore possesses great advantages for the lighting of all places where many persons are crowded together, either for work or amusement. Many proprietors of workshops and factories have reported that, independently of the additional work accomplished by reason of the superior illumination, operatives are able to do a much larger amount of work under electric lights than under gas or oil lights, because of the freedom from headache and other ills directly attributable to the latter.

The special advantages claimed for the electric light, and which are now well recognized, are:

Economy, as compared with gas, or any other means of lighting, the amount of light produced being considered.

Purity, every shade of color being as readily identified as by daylight.

Healthfulness, the amount of heat produced and oxygen consumed being unappreciable.

The special advantages claimed for its system by the Fuller Electrical Company are:

Completeness of system.

Durability of apparatus.

Steadiness and quality of light.

Economy of power.

The company claims for its dynamo-electric generator that it occupies less space, weighs less, requires less motive power, and costs less than any other capable of producing an equal number of lights.

It claims, further, that there is less flashing or firing of the commutator, and consequently less loss of energy and wearing of the parts from this cause than is the case with other machines, and that its commutator requires no oiling or other attention than to be kept clean. Its extreme simplicity enables it to be operated with less skill and attention than are required by others.

The current regulator and signaling apparatus, by which the machine is made to generate the exact current required for any number of lights, from one to its full capacity, as they are turned off and on without change of speed or waste of power, is simple, effective, and safe.

Its lamps are reliable in operation, the carbon regulating apparatus being absolute in its control, durable, and unaffected by changes of temperature or weather. They are of ornamental design, and the company claims that they cost less than those of other companies, and that the steadiness and purity of light produced are unequaled by any others for an equal expenditure of power.

All the apparatus put in operation by this company is made to conform in every particular to the requirements of the New York Board of Fire underwriters, a copy of which is furnished to all experts in the company's employ, and also to all those who use the company's apparatus, together with full directions for setting up and operating the machinery in all details.

No better evidence of the efficiency of the Fuller system could be presented than the subjoined copy of the report of the Street-Light Committee of the Bay City, Michigan Common Council, made last July:

"GENTLEMEN—Your committee who were instructed by your honorable body to negotiate with different electric light companies, for the purpose of establishing a city electric light works, to be owned and maintained by Bay City, and who were further instructed to visit Chicago, and Dayton, Ohio, to investigate and inquire into the merits of the different electric-lighting systems, hereby respectfully present their report in the premises to your honorable body.

"We find, as a result of our investigations into the merits of the different systems, that the light and apparatus of the Fuller Electrical Company of New York, are by far the best seen by your committee, and altogether superior to those of other systems. The electro-dynamic engine of this company is remarkable for its simplicity of construction, compactness, and facility of running. In proportion to the number of lights furnished, this generator occupies a much smaller space than that of any other system, and a much smaller horse-power is required to run it, thus reducing the cost of running it, and the cost of boiler and engine. From its simplicity of construction, it is almost impossible for the generator to get out of order or burn the armatures. The lamps of this company are so constructed as to keep the carbons at equal distances at all times, thus securing a degree of steadiness incomparably greater than yet attained in any other lamp. The contrast between the Fuller lamps . . . . and other lights in juxtaposition with them, as seen by your committee in Chicago, was so remarkable in this respect as to force itself upon the attention of your committee and of many citizens of Bay City who were visiting

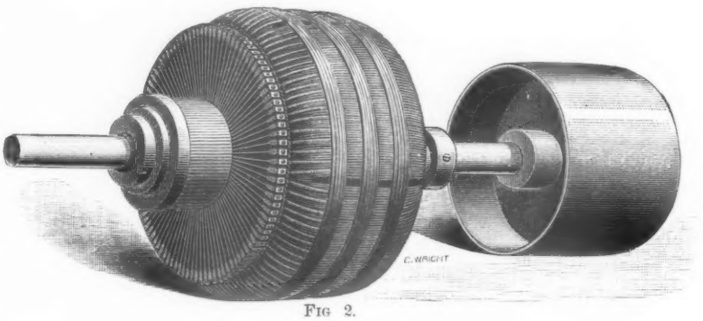


FIG 2.

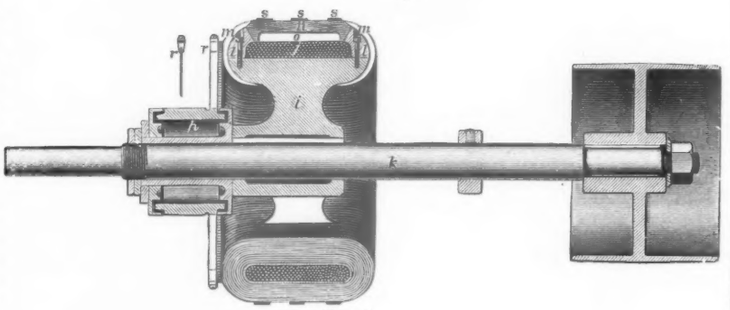


FIG. 3.

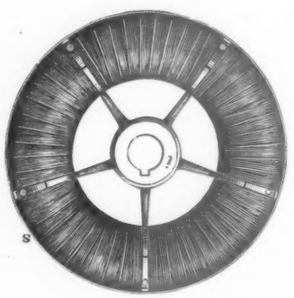


FIG. 4.

Chicago at that time. The quality of the light is conspicuous for its brilliancy and purity, being essentially a white light, and almost achromatic.

* * * * * *

"The satisfaction given by the Fuller light in Chicago is so great that they are replacing the old lights of the other systems, which are being taken out to make way for the newer and better light of the Fuller system. Your committee had the satisfaction of seeing in actual operation dynamic engines of this company, of all sizes, furnishing from three to fifty-five lights respectively. In one basement of 25x40 feet, about, we found steam boilers and forty-horse power engine, furnishing in all thirty-three lights, and there would easily have been place for a fifty-five-light machine. The whole thing was operated by two men, a fireman and an engineer, who took entire charge of the steam engine and dynamos. The small space required for the working of a large number of machines of this company is certainly as remarkable as the small horse-power required. In another place, in an equally small basement, we saw in operation 80 lights furnished by 55 and 25-light machines, respectively, the whole running by a 75-horse power engine, and the gentleman owning the plant informed us that they expected to put 25 more lights in the same establishment without increasing the horse-power, thus making over 100 lights in one small establishment, run by a 75 horse power engine—sufficient to light Bay City better than it is by the present electric company. In Dayton, O., we found the city illuminated by 60 Fuller lights, suspended in the center of the intersection of the streets, on a total circuit of fifteen miles. The longest is an eight-mile circuit, furnished by a 20-light machine. The first and last light on the circuit are only two blocks apart, and the last light is as steady and as brilliant as the first. The superior results obtained by this light and by the method of suspending the lamps were voiced in the unanimous verdict that Dayton is the best lighted city ever seen by our visiting members. . . . . The light gives satisfaction, and the richest and most influential citizens show entire confidence in it. It should be mentioned that the company is working under difficulties at present, not having completed their works nor put in all their lights. We would further state that all our information furnished in this report was derived from actual inspection of lights, machinery, &c., and from practical engineers and machinists engaged in the business. To sum up, after seeing all the different arc lights, we consider the Fuller lights by far the best and cheapest, and would recommend that the city adopt that system.

As the electric light is produced by the electric current, it is indispensable, for securing the best result, that there should be uniformity in its production. This requires that the speed at which the dynamo-electric machine is operated shall be as nearly as possible uniform. To secure this regular and steady motion the motive power, whether driven by water, air, gas or steam, should be sufficient to do the work required easily.

In all cases it is more economical to have the motive power of abundant capacity, so that it shall not be reduced below the minimum, when unfavorable conditions occur.

The following table shows the several standard sizes of machines manufactured by the Fuller Company, together with interesting data respecting each size.

Motive power, of which a safe outside estimate is three-fourths of a horse power per light of 2,000 candle power, for generators of ten-light capacity and upwards, and one-horse power per light for smaller generators.

The carbons consumed, amounting to from one to one and one-fourth cents per light per hour.

Attendance of a man or capable boy, to properly clean the lamps, and to put in new carbons ready for "lighting-up time."

The care of the generator will add little to the duties of the engineer in charge of the motive power employed, it being only necessary to see that the brushes are properly set and so maintained, and the oil-cups filled.

In case of street lighting, or the operation of an extensive plant from a central station, the services of a competent expert and lineman are, of course, necessary; the extent of such service depending upon the extent of the plant.

To put the electric lighting apparatus in working order is not expensive, the principal item being the insulated copper conducting-wire. Where there is suitable shafting a pulley will be required, in other cases a counter-shaft and belt. These, with a substantial foundation for the generator, which should always be provided, and the labor of putting the machinery in position, are all the requisites.

In the following table will be found a series of accurate computations regarding the Fuller Company's lights, together with cost of same:

No.	Number of Lights.	Nominal Candle Power per Light.	Horse Power Required	Size of Pulley in Inches. Dia.	Size of Pulley in Inches. Face.	Width of Belt.	Revolutions per Minute.	Weight. Lbs.	Floor Space Occupied.
1	One	6,000	3	5	3½	3 in.	1,350	250	10×24 in.
3	Three . .	2,500	4	5	3½	3 "	1,550	250	10×24 "
5	Five . . .	2,000	5	6½	4½	4 "	1,300	600	12×30 "
6	Six	2,000	6	8	5½	5 "	850	900	14×85 "
9	Nine . . .	2,000	8	8	5½	5 "	1,075	900	14×85 "
20	Twenty.	2,000	15	12	9	8 "	950	1,850	18×40 "
25	Twenty-five. .								
30	Thirty. .	2,000	18	12	9	8 "	950	1,850	18×40 "
50	Fifty. . .	2,000	22	13½	10	9 "	925	3,100	21×50 "
			37	16	11	10 "	850	3,500	23×55 "

No better evidence of the practical value and commercial success of the Fuller lights could be had than is furnished by the list here appended, of those who use them.

Local companies operating renting plants of Fuller Co.'s apparatus, from central station:

The St. Paul Gas Light Co., St. Paul, Minn.

The Wheeling Electric Light Co., Wheeling, W. Va.

The Dayton Electric Light Co., Dayton, Ohio.

The City of Xenia, Ohio.

E. W. Hydorn & Son, Troy, N. Y.

The St. Clair Electric Light Co., Belleville, Ill.

The Springfield Electric Light Co, Springfield, Ill.

The Baxter Electric Light Co., Jersey City, N. J.

The Penn. Electric Light Co., Harrisburg, Pa.
The Hot Springs Electric Co., Hot Springs, Ark.
The Michigan Light & Power Co., Grand Rapids, Mich.
Some of the principal establishments owning and operating isolated plants of the Fuller Co.'s apparatus :
Ware, Pratt & Co., Worcester, Mass.
Washburn Iron Company, Worcester, Mass.
H. H. Bigelow, Worcester, Mass.
Wm. Allen & Sons, Worcester, Mass.
Blair-Fiske Mfg. Co., Springfield, Mass.
The Geneva Worsted Mills, Providence, R. I.
Robt. Rodman's Woolen Mills, Lafayette, R. I.
Robt. Rodman's Cotton Mills, Wickford, R. I.
Pratt & Whitney, Machine Works, Hartford, Conn.
Garner & Co., Rockland Print Works, Haverstraw, N. Y.
Lord & Taylor, Grand and Chrystie Sts., New York.
Lord & Taylor, Broadway and 20th St., New York.
Old Dominion Steamship Co.'s Pier, N. R., N. Y.
United States Express Co., 82 Broadway, New York.
Smith & McNell's, Greenwich Street, New York.
The Grand Opera House, Brooklyn, N. Y.
Eagle Mills, Brooklyn, N. Y.
Gutta Percha and Rubber Co., Brooklyn, N. Y.
Brady Mfg. Co., Brooklyn, N. Y.
Dixon & Wilson, Fulton Street, Brooklyn, N. Y.
C. G. Gunther, Locust Grove, L. I.
The Curling and Skating Rink, Toronto, Canada.
Lutcher & Moore, Orange, Texas.
Case School of Applied Science, Cleveland, O.
Cable Flax Mills, Schaghticoke, N. Y.
Wheeler & Wilson Mfg. Co., New York.
Fort William Henry Hotel, Lake George, N. Y.
San Souci Hotel, Ballston, N. Y.
The Sanitarium Co., Clifton Springs, N. Y.
D. W. Powers, "Power's Block," Rochester, N. Y.
Wm. Gleason, Mfg. Machinists' Tools, Rochester, N. Y.
American Grape Sugar Company, Buffalo, N. Y.
John T. Noye & Sons, Buffalo, N. Y.
M. H. Birge & Sons, Buffalo, N. Y.
Jersey City Steel Company, Jersey City, N. J.
Doherty & Wadsworth, Silk Mills, Paterson, N. J.
J. Bamford, Silk Mills, Paterson, N. J.
Baldwin Locomotive Works, Philadelphia, Pa.
Dickson Manufacturing Company, Scranton, Pa.
Greenwood Rolling Mill Company, Tamaqua, Pa.
Pennsylvania Steel Works, Steelton, Pa.
Kellogg & Maurice, Bridge Works, Athens, Pa.
Watt, Shand & Co., Lancaster, Pa.
Conestoga Mill No 2, Lancaster, Pa.
Shultz Brothers, Lancaster, Pa.
Brace Brothers, Pittsburgh, Pa.
Myers & Rathfon, Lancaster, Pa.
J. H. Boyle, Toronto, Canada.
A. E. Allen, Jamestown, N. Y.
Baltimore Car Wheel Co., Baltimore, Md.
Jefferson Iron Works, Steubenville, Ohio.
The Junction Iron Co, Mingo Junction, Ohio.
L. Spence, Martin's Ferry, Ohio.
Anton Meyer, Brewery, Terre Haute, Ind.
South Tredegar Iron Co., Chattanooga, Tenn.
Cochrane & Co., Memphis, Tenn.
C. P. Kimball & Co., Chicago, Ill.
Chaplin & Gore, Chicago, Ill.
Wardell & Hinckley, Chicago, Ill.
Leland Hotel, Chicago, Ill.
Studebaker Brothers, Chicago, Ill.

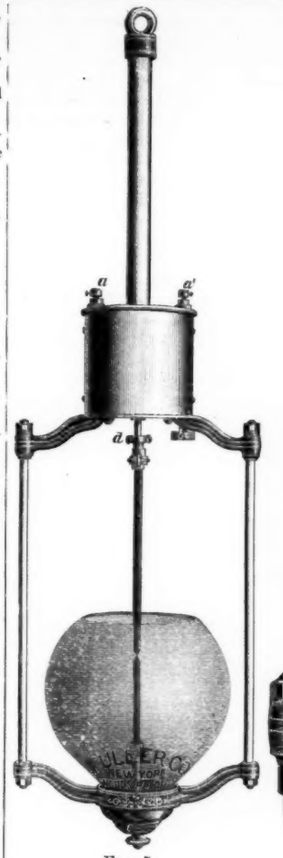


FIG. 5.

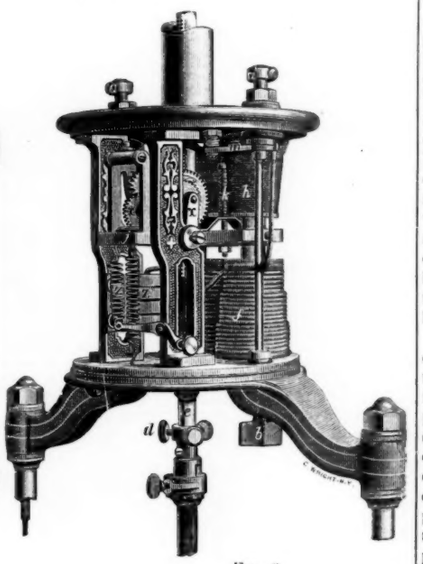


FIG. 6.

E. M. Dickey, Dubuque, Iowa.
W. & J. Fleming, North McGregor, Iowa.
Molera & Cebrian, San Francisco, Cal.
Weyerhauser & Dinkman, Rock Island, Ill.
Adams Electric Co., St. Louis, Mo.

The Generator.

Fig. 1 represents the form of dynamo-electric generator adopted and manufactured by the Fuller Electrical Company, which has come into extensive use during the past three years.

J. V. Farwell & Co., Chicago, Ill.
A. Weber, Chicago, Ill.
State Penitentiary, Joliet, Ill.
North Western Screw Co., Chicago, Ill.
Munger Bros., Chicago, Ill.
A. E. Austin, Chicago, Ill.
Southern Illinois Penitentiary, Chester, Ill.
The State Penitentiary, Waupun, Wis.
Michigan Iron Works, Grand Rapids, Mich.
Thos. S. Tew, Big Rapids, Mich.
St. Louis Bridge & Tunnel Co., St. Louis, Mo.
St. Louis Bolt & Iron Co., St. Louis, Mo.
Aug. Gast & Co, St. Louis, Mo.

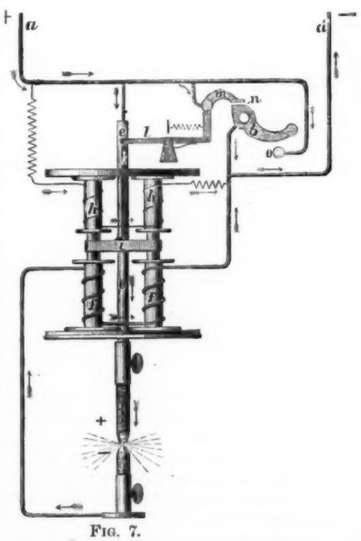


FIG. 7.

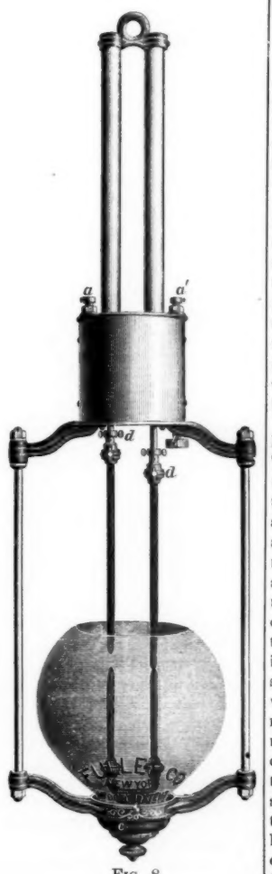


FIG. 8.

Geo. S. McConkey, Toronto. Ont.
Santa Eulalia Mining Co., Chihuahua, Mexico.
A. Y. McDonald, La Crosse, Wis.
P. S. Davidson, La Crosse, Wis.
Matt Clark, La Crosse, Wis.
Capt. Van Sant, Davenport, Iowa.
Durand, Wheeler & Co., Stillwater, Minn.

This machine was designed by Mr. James J. Wood, the electrician and mechanical engineer of this company.

In its electrical connections it is the same as the Gramme machine. It is made in sizes of from 300 pounds weight, generating a current of thirty ampères and sixty volts at a speed of 1,250 revolutions per minute, producing one light of 6,000 nominal candle-power, to 3,500 pounds weight, generating a current of ten ampères and 2,500 volts, producing fifty-five standard lights of 2,000 nominal candle-power, at a speed of 850 revolutions per minute, being the largest machine in lighting capacity, although not in weight, of any ever put in practical operation. The advantages claimed for this generator are, 1st, the construction of the field is such as to produce the maximum of magnetism with the minimum of current. The field is constructed of rectangular bars (*a a*) of wrought iron, with rounded edges. The ends (*b b*) are constructed of heavy cast-iron plates. The pole pieces (*c c*) are of cast iron, bolted to the rectangular magnetic bars, and secured at their ends by non-magnetic composition plates. The current regulator (*d*), which is on the front end of the machine, is a hand-wheel designed for placing the brushes which collect the current in a position around the commutator from the maximum to the minimum point, or vice versa as required. This wheel is graduated so as to represent the number of lights the machine is designed to operate. A spring latch (*e*) holds the wheel in a position corresponding to the graduation, to represent the different numbers of lights.

The brushes which collect the current are connected with coils of the field of force magnets, in such a manner that the current from the brush at one side of the commutator passes through the two top magnet coils (*ff*), and thence to a binding post (*h*) the current from the opposite brush of the commutator passes through the under coils (*g g*), thence to a corresponding binding post. These binding posts are on the end of the machine nearest the pulley, and are so placed as to prevent the possibility of coming in contact with both posts at the same time, unless by design, thus removing an element of danger common to many forms of dynamo-electric machines.

Fig. 2 represents a perspective view of one of the armatures of these machines. Figs. 3 and 4 represent a sectional elevation and end view of the armature showing its interior construction. In the sectional elevation, (*i*) represents the spider, which is made of gun metal, and to which the iron ring (*j*) on which the coils of copper wire are wound, is fastened, the whole being firmly keyed to the shaft (*k*). This ring, which is composed of annealed iron wire, insulated in process of manufacture, is in direct contact with the gun-metal spider, the object of this being to absorb any heat that may be produced in the ring (*i*). The spider is so constructed as to produce a fan-like motion, causing a strong current of air to circulate through it, dispersing the heat as rapidly as it is produced.

The small caps (*l l*), held by screws (*m m*), hold the iron ring of the armature in position. The wooden strip (*n*), with the space (*o*), of which there is one in each arm, prevents the generation of currents in the caps (*l l*) and also serves as a means of balancing the armature. The advantage of this will readily be seen from the fact that the balancing is done exactly at the periphery, and not near the center, as is the case with other forms of armatures. The commutator (*p*) is composed of sections of copper insulated from one another, and so constructed that any section can be removed without materially interfering with the remaining sections. This commutator is connected with the armature by a peculiar form of screw clamp (*rr*), and is not soldered, as is the case in other machines. An important advantage claimed for this armature over the original form of Gramme, is that it has little or no tendency to short circuit or to become overheated. In the older forms of Gramme armatures, the center is composed of a wooden block, which is driven into place under great pressure, tending to disarrange the wires and injure the insulation, and entirely preventing any circulation of air through them. In the older forms the coils after a time pack very tightly, the hub sometimes becomes loose, and the proper balance is destroyed ; a condition which it is impossible to entirely correct, but which cannot

occur in the new form, as there is no strain whatever on the conducting wires.

Another peculiar feature in the construction of this armature, and an improvement over that of older forms, is in the fact that, where the connecting wires are attached to the commutator, they are enlarged to four times their sectional area, which enlargement continues as far back as the band (*s s s*) so that the wires are held rigidly in position, thereby preventing any tendency either to vibrate or break. In machines constructed heretofore for high tension currents, in which small wire is necessarily used in the armature coils, the constant vibrations of the wires at the point of attachment to the commutator rendered them hard and brittle, so that in a short time they would break, and in some instances machines were seriously damaged in consequence. The plan above described effectually prevents such a result.

THE SINGLE LAMP.

Fig. 5 illustrates the Fuller Electrical Company's standard arc lamp, also designed by Mr. Wood. There are several novel features in this lamp.

The framework is perfectly insulated from the circuit, and water-tight, the lamp requiring no hood to protect it from the weather; the binding posts (*a a*) are constructed in such a manner that the circuit wires enter them at the top instead of at the sides, as in older forms of lamps, so that if the connections become loose from vibration, or otherwise, they will always tend to hold a contact, due to gravitation, as the weight of the wires will still hold them in position. These binding posts also serve as bolts to hold the insulated roof plate in position as shown in Fig. 10.

Another feature deserving of note is the peculiar construction of the hand-switch, (*b*) which is similar to a gas key, and can be operated from below to turn on or off the light in the same manner as in the use of gas. The ornamental cup (*c*) at the bottom of this lamp is so arranged that the carbon dust, which accumulates as the carbons are consumed, falls into it. It is held in position by a bayonet joint to facilitate its removal for cleaning, being not only a great convenience, but enabling the cleaning to be much better done than in other systems in which the dust must be blown out, a process at once slovenly, awkward, and incomplete.

The positive carbon-holder of this lamp is fitted with a universal adjustment (*d*) for bringing the carbon points in line.

Fig. 6 represents a perspective view of the interior of the lamp illustrated in Fig. 5. Fig. 7 is a diagram illustrating the direction taken by the current in passing through the lamp to produce the light. Also the action of the automatic cut-out, operated by an abnormal attraction of the magnets in case the lamp fails to feed. The current enters at the upper left hand corner, marked (*a*), following the direction of arrows to the feed-rod (*e*) to the positive carbon, through the arc, thence through the negative carbon, and back through the heavy connection around the magnets (*f f*), thence to the right of the figure and out to the next lamp. The action of this will readily be understood if we consider the carbons are in contact. The current will then flow in the direction shown by the arrows, through the carbon rod (*e*,) through the carbons, thence through the magnets (*f f*), which will powerfully attract the armature (*i*,) which, through the agency of the lever (*j*,) as shown in fig. 6, will produce the separation of the carbons. The magnets (*h h*), in the shunt circuit around the arc, have a very high resistance, so that when the carbons are together practically no current flows through them, but the instant the carbons are separated, the current will divide itself inversely as the resistance of the arc and shunt-magnet circuit, causing a greater proportion of current to flow through them, which proportion will increase as the carbons are consumed, until the arc becomes of normal length. When this occurs, the attractive force of both magnets is balanced. If the arc increases in length, the attractive force of the magnets (*hh*) will preponderate, attracting the armature (*i*) in that direction, causing the carbons to feed. In case of a failure of the carbons to feed from any cause whatever, the magnets (*h h*) will continue to increase in strength until the pin (*k*) comes in contact with the lever (*l*), tripping the cut-out lever (*m*), closing the contacts (*n*), and automatically cutting the light out of circuit. In case it is desired to switch the lamp out of circuit by hand, the switch (*b*) is moved so as to close contact with the knob (*o*), which sets the cut-out so as to be again operated by the magnets, when the lamp is again put in circuit.

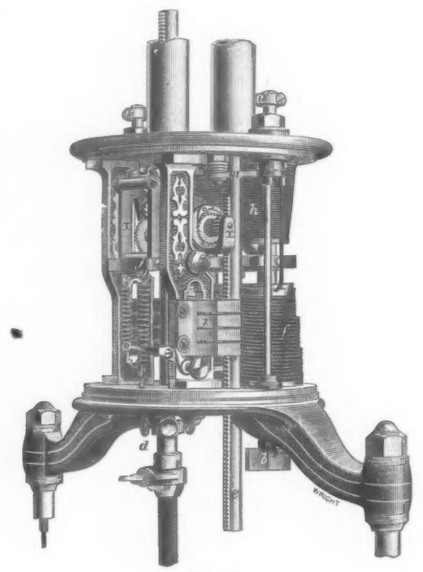


FIG. 9.

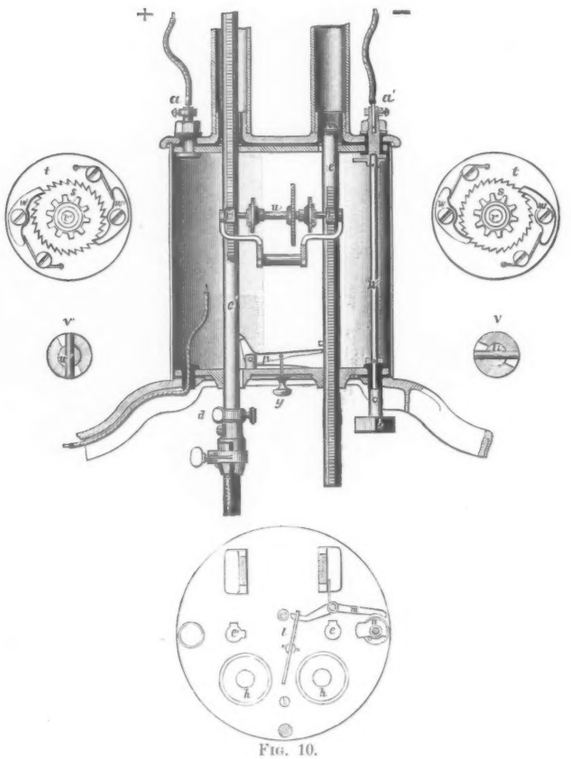


FIG. 10.

These movements are so arranged that no contact is broken until another has first been formed, thus avoiding all sparks and consequent injury.

The purpose of the adjusting spring (*z*) is to govern the length of the arc, which is easily regulated by turning the screw (*z'*).

The purpose of the permanent balancing spring shown in figures 6, 9, and 12, at the right of the adjusting spring, is to so far preserve the adjustment as to continue the lamp in operation even when the spring (*z*) is improperly used, as sometimes occurs from ignorance or carelessness.

The purpose of the comb spring (*z''*) is to insure positive contact with the feed rod, thus maintaining the path of the current without depending upon the feeding mechanism therefor. At (*x*) will be seen a small train of clock-work, the object of which is to retard the downward movement of the rod (*e*), thus securing a steady light.

THE DUPLEX LAMP.

Fig. 8 gives an exterior view of the standard Automatic Duplex Lamp, for all night illumination. The burning capacity of this lamp is from 14 to 16 hours without replacing the carbons. The general construction of the frame as to insulation, convenience and appearance is the same as that described in fig. 5. The difference is, as will readily be perceived, that this lamp is designed to feed two sets of carbons consecutively.

Fig. 9 is a perspective view of the interior construction of this lamp.

Fig. 10 is a sectional and plan view, showing the main features of the feed mechanism, cut-out switch and method of insulation. The action of this lamp may be described as follows: The feed-rod (*e*) to the right of the figure is called the leading rod; that is, the rod which first comes into action. The other rod (*e'*) being held in position by the latch-lever (*p*) As the carbon is consumed in the rod (*e*) it feeds forward until near the end of its travel the pin (*q*) comes in contact with the lever (*p*) tripping the rod (*e'*) The instant that this occurs the rod (*e*) has reached the bottom of its travel, and can go no further, and leaves a space between the carbons equal to the length of the arc. After the rod (*e'*) is tripped it will feed forward until the carbons at this side of the lamp come in contact; the current will then pass through this set of carbons which offer the least resistance, breaking the arc and extinguishing the light in the former set. A peculiar feature of this lamp is that while both feed rods are connected positively together with a single movement, the lamp having but a single set of magnets, there is no instant in its whole operation that both rods are acted on at the same time. The method of accomplishing this is as follows: the pinions (*r r'*) gear into their respective rods (*e e'*), and are fastened to a ratchet wheel (*s s'*) which gears into the driving discs (*t t'*). These discs fit loosely on the spindle (*u*), having a certain amount of motion around the axis of the spindle, which motion is about equal to that produced by the separation of the carbons. If we consider the rod (*e*) to be feeding its carbon forward, and the rod (*e'*) to be latched as shown in figure 10 it will readily be seen that the pinion (*r*) becomes the driver, and will revolve the disc (*t*), taking up the play as shown in the section (*v*) transmitting a rotary motion to the spindle (*u*), which in turn will cause the disc (*t'*) to revolve, taking up the play in the opposite direction as represented in the section (*v'*). Now, as will be readily seen, the pinion (*r*) at the right hand of the figure being the driver, the disc (*t'*) at the left hand of the figure will be driven around the ratchet wheel and pinion (*r'*), causing the pawls (*w w'*), to slip as the pinion (*r'*) is geared directly to the feed-rod (*e'*), which rod being latched in its upright position prevents the pinion from revolving without disengaging it for an instant from the main train (*x*), shown in fig. 9. The advantage of this will be appreciated, if we consider that if one pinion were disengaged while the other was operating, there might be a time when it would be difficult to reverse the connections without causing the teeth to strike on the tops of each other, or allowing the rod to fall too far. When the rod (*e'*) is tripped so as to set it in motion the action is reversed.

The purpose of the button (*y*) is to facilitate cleaning and replacing carbons in the lamp. By pressing it downwards both carbon rods are brought into simultaneous action.

Fig. 10 is a sectional and plan view, showing the action of the hand-switch and the automatic cut-out. In the figure, (*n*) represents a cam-shaped piece, which is in direct connection with the spindle (*n'*) and the key (*b*), which compose the hand-switch. The action of this may be described as follows: The end of the spindle (*n'*) is seated in a bearing at the inside of the negative binding-post (*a'*), which is insulated from the framework of the lamp, and is of negative polarity. When this is in the position shown in the figure, there is a space between this cam and the cut-out lever (*m*). This cut-out lever is in direct connection with the positive binding-post (*a*). By turning the key (*b*) one quarter, the projection of the cam (*n*) is brought in direct connection with the lever (*m*), switching the lamp out of circuit; by turning the key in the opposite direction, these connections will be broken and the lamp again switched in circuit. The operation of the automatic cut-out described in Fig. 7, in case of failure of the lamp to feed from any cause, or when the carbons are consumed, is produced by tripping the latch (*l*), and allowing the lever (*m*) to automatically close contact with the cam (*n*).

All that is required to put this lamp back in circuit, after automatic extinguishment, is to turn the key (*b*) in the direction to switch the lamp out, and then back to switch it in, as before described.

On Electrical Ring Figures.

By A. Righi.

If a discharge is conveyed through a point upon a dielectrical plate, which has beneath a conductive coating, we sometimes obtain, on dusting the plate with red lead and sulphur, if the charge is positive, instead of a yellow star, a yellow ring, with a reddish, indistinct disk in its middle. If the charge is negative, we obtain instead of the red disk a very regular red ring, in which there appears a red star

The cause of the phenomenon is as follows:

If, upon a perfectly insulated sewing needle, fixed over a horizontal disk of ebonite, and provided with a ball above, a spark is allowed to issue from the inner coating of a jar, and if the plate is dusted, there appears the well-known figures. If, however, the needle is badly insulated, or if it is touched with the hand, the rings appear.

On supplying, *e.g.*, positive electricity by means of the point, the upper surface of the ebonite is at first charged positively and the under surface negatively. If the point is badly insulated, the upper surface is again discharged, and negative electricity passes over upon it. If the quantity of electricity discharged is smaller than that supplied by the charge, then the middle only of the charged part becomes negative, and the circumference remains positive.

If the point is too far removed from the plate, there appears only the ordinary figure; if it touches the plate, and if a second point is applied above it, we obtain certainly the rings, which belong, therefore, to the figures from which Bezold sought to deduce the oscillations of the charge.

If the ebonite disk is moved in its plane, the internal space of the ring is displaced towards the point, or it ceases to be circular.

If the point and the posterior surface of the ebonite disk are connected with the conductors of the Holtze machine, the disk turned a little, and the conductors pushed together, we obtain, likewise on dusting, from the reasons mentioned above, the ring figure If, after charging the plate, both the point and the coating are thoroughly insulated, and if the plate is slowly and continuously dusted, touching alternately the point and the plate, we obtain in succession larger and larger rings.

If the experiment is conducted in the ordinary manner, but if a badly conducting medium—a glass tube filled with water—is placed between the point and the coating of the plate, we obtain rings; the ebonite plate being first charged and then discharged by the column of water.

On the Resistance of the Electric Arc.

By O. Frölich.

If we determine the potential difference, E, at the electrodes of the arc and the strength of the current, J, then E/J is the apparent resistance of the arc, which may be composed of the real resistance, and an electromotive force.

In a graphic representation of the arc lengths, L, as abscissæ, the potential differences as ordinates, the strongly indented curve oscillates about a gradually ascending right line, whence $E = a + b\,L = 39 + 1.8\,L$, if L is measured in millimeters and E in volts. The apparent resistance, W, of the arc is then

$$(1.)\quad W = \frac{a}{J} + b\,\frac{L}{J}$$

If there exists an electromotive force or polarization, P, of the carbons, and if k is the conductivity and Q the section of the arc, then

$$(2.)\quad E = P + \frac{J}{k}\frac{L}{Q};\quad W = \frac{P}{J} + \frac{1}{k}\frac{L}{Q}.$$

If there is no polarization, and merely a resistance to transit, U, then

$$(3.)\quad E = \frac{U}{Q}J + \frac{J}{k}\frac{L}{Q};\quad W = \frac{U}{Q} + \frac{1}{k}\frac{1}{Q}.$$

If the formulæ (2) and (3) agree with (1) the section of the arc must be proportional to the strength of current, therefore Q = const. J. If const. = 1 or Q/J = 1, then a is the limit of the polarization or of the resistance to transit for the section 1, and b the inverse value of the conductivity of the arc. The formulæ do not give a decision for either assumption.

The work in the arc is:

$A = E\,J = (a + b\,L)\,J$. It is, therefore, proportional to the strength of the current, and, though remotely, to the strength of the light.

The observations have been made at the establishment of Siemens & Halske with arc lengths of 1 — 16 *mm.*, and with strengths of currents of 4 — 120 ampères.

An Improved Hand-Power Dynamo.

Fitchburg, Mass., Dec. 1, 1883.

Since the introduction of electricity for illumination, for plating, and for the general run to which it is now put, there has sprung up a considerable demand for a powerful and economical working dynamo, suitable for general experimenting.

A great many experiments in which parties may be interested, and without doubt would perform if they had a powerful and economical source of electricity at hand, are not undertaken on account of the time, expense and trouble required to properly arrange a galvanic battery for working order. In this way they lose an opportunity of attaining the practical knowledge and enlarged experience to which such experimenting always leads.

We illustrate a machine which seems to fill a want long desired. The object was to produce a machine capable of developing a current of electricity of sufficient quantity and intensity to meet the demands of any laboratory, and one absolutely free from the defects common in other machines of this class.

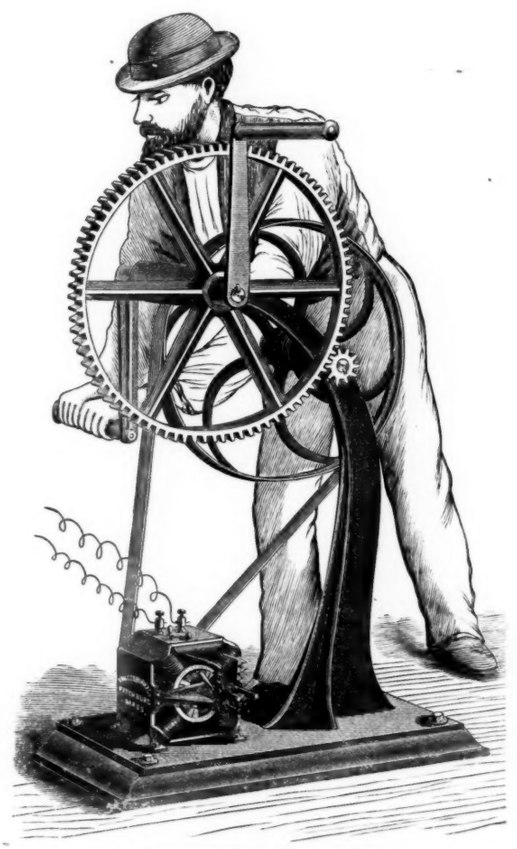
These machines, we are informed, are more successful in their action than the parties at first dared to hope for. With these machines the current can be perfectly regulated. They are simply and compactly constructed, giving a very powerful and even current, and would be an ornament to any lass-room, office or laboratory.

They furnish a current of sufficient power to operate three incandescent lamps, each of sixteen candle-power, or one small arc light sufficiently strong for illustrative purposes. The machine requires about two man-power to operate it up to its fullest capacity, but one man can develop sufficient electrical energy for general experimenting, the current developed being according to power expended in operating machine.

When convenient, machine may be operated by steam, water or any other power party may have at command, and in such case it may be run continuously if desired

The machine, besides being very useful for general experimenting, is used to a considerable extent for practical purposes. A large number have been constructed for country use, and in every case have they given the best satisfaction.

With the use of this machine for country, a great deal of annoyance is avoided by the surgeon having the operation in charge.



An Improved Hand Power Dynamo.

Will heat, while hot, a long piece of No. 16 platinum wire.

The machine is made very rigid, and runs perfectly even and free from noise, the gear being cut and not cast.

The dynamo, in its general design, is very similar to the lighting machine made by I. W. Colburn & Co., having all the improvements that are upon said machine. The only material difference between them is in the size and capacity. Particular pains have been taken both in designing and in the material used in construction to make this the very best machine in the market.

As will be seen, the machine rests upon a heavy and strong iron base, with an upright column all cast in one piece. The weight of base and column is 375 lbs. There are bolt-holes in base for securing machine to floor. The machine is so speeded that, with a slight exertion on the part of person operating crank, a very fast speed can be attained for the armature.

The machine can be run up to a speed of 1,800 revolutions per minute, and kept there without showing any heat in armature or field coils.

The frame of machine is cast in one piece, and thus given its absolute rigidness; besides, the bolt pieces of the exciting field are all secured to a solid composition ring, one on each side of poles. Machine is thus enabled to run perfectly free from vibrations.

The armature is of the improved Gramme type. Current passes from armature coils through insulated wires in center of shaft to the commutator, which is outside the bearings. This gives easy access to brushes, and they can be easily adjusted.

Unlike other machines, the commutator brushes, instead of being horizontally parallel, are set at an angle of 70 degrees from each other.

The machine, when constructed for experimental purposes, is wound with quite small wire, and furnishes a current of 60 volts and 3½ ampères; when constructed for country use, it is wound with large wire, and then develops 4 volts and 50 ampères.

These machines are very useful for professors in schools and colleges in illustrating the science of electricity; also to enable them to facilitate their searches in this line. With this machine all the experiments possible with a battery, and many for which a battery is unfit, may be successfully performed.

Very little space is occupied, and after first cost there is nothing to be figured as operating expenses, unless it is the interest on money invested, and that is so slight as not to be worth the reckoning. The first cost of machine is a trifle more than that of a chemical battery of same power; but the cost of the battery, after one month's use, would far exceed that of the dynamo, and the battery would be much out of repair, while the dynamo would be in perfect order.

Any person desiring information not given in this article may obtain it by writing the makers, I. W. Colburn & Co., at Fitchburg, Mass.

Improvements in Electric Batteries.

The action of the element is regulated by non-porous screens which slide over the porous cells. The outer vessels are widened below the plates and cells so as to permit of the use of a large quantity of liquid.

The Smith-Woolly electric headlight for locomotives was tested recently at Indianapolis. The light was claimed to be 7,000 candle-power, and produced a distinct illumination of the track at a mile's distance. No difficulty was experienced from the jolting of the engine.

The Brush Company announces improvements in the armature of its dynamo which largely increases its capacity. Thus an improved No. 8 dynamo, which formerly gave 40 lights of 2,000 candle-power, will now give, it is claimed, from 55 to 60 lights of 2,000 c. p., or from 75 to 80 lights of 1,200 c. p.

The Brush Electric Light Company is now ready to take orders for storage batteries to be delivered within three months' time.

A 50 incandescent light plant has recently been installed at the works of the Chauncy Rubber Company, Reading, Mass.

New Chromic Acid Battery.

By M. Moncl.

Six glasses perforated at the bottom are set in a lead tray, fitted with a lead siphon for running the liquid in and out. In each glass there is a zinc plate and two carbon plates. As liquid is used, a solution of one kilo bichromate of potash in four litres of water and two litres of hydrochloric acid.

The Ball Electric Manufacturing Company, of Reading, Pa., have applied for a charter. The company will manufacture the electric inventions of Messrs. Charles E and R. E. Ball, of New York, and W. H. Spang, of Reading, which consists of dynamo-electric machines, arc and incandescent electric lights and electric motors.

Telephonic.

Kansas City and North-Western News.

Twenty-five telephones were put in last week in this exchange, and the manager reports a large number of applicants' names still on file. In Leavenworth, an increase of five subscribers is noted for last week, and Topeka comes to the front with an increase of four. Hannibal, Mo., has increased forty-five in the last two months. A pleasant little town of about four thousand inhabitants is Junction City, Kan., about the center of the State, and that its citizens are appreciative of modern electrical conveniences is shown in the fact that there are upwards of seventy-five telephones in use there. This little city is in the territory of the United Telephone Company, and the home of its president, W. B. Clarke.

The multiple switchboards in use by the Kansas City exchange are giving much satisfaction to subscribers and officers. That there has been so little friction from the start—everything being new, and these switchboards being the first of the kind set up—can be largely attributed to the careful and intelligent work of Mr. Al. Barrett, formerly with the factory of E. T. Gilliland, at Indianapolis. Every step taken was carefully tested, and when the whole was completed there was, as a natural consequence, no annoying blunders or defects. There will be another switchboard, of two hundred drops, placed in this exchange the first of the year, giving it a capacity of eight hundred subscribers.

In Kansas, the telegraph boys fully realize the excellencies of the telephone, and are in the habit of attaching a telephone to each end of a telegraph wire, extending from one city to another, and using this as a means of communication at night, when telegraphing over the lines has stopped and there is little disturbing induction. Between Newton and Emporia and Newton and Wichita this is often done.

There are some mysteries connected with the operating of long telephone lines that make superintendents and managers gray-headed. A few days ago, the line extending from this city north to Atchison, a distance of nearly fifty miles, seemed to lose all interest in its business, and for about three days communications were very faint, yet when St. Joe—a city twenty-one miles further away—was put on the line would work unusually well. In explaining this, we follow the advice of a very prominent American Bell official, "Look wise, and call it induction."

In one respect the telephone is certainly appreciated in Kansas City. The entire fire-alarm system depends on it. Chief Hale, of the fire department, is a staunch admirer of the invention of Mr. Bell, and at a recent meeting of the chiefs in New Orleans made a strong speech in support of the telephone as a quick means of reporting fires.

Kansas City is so spread out, over numerous hills and bluffs and bottoms, that to construct a Gamewell fire-alarm system would cost so much that the city fathers have not seen their way clear to ordering it built. Realizing the advantages of the telephone in this respect, the chief of the fire department has made, with the generous co-operation of the telephone company, arrangements so perfect that the firemen of this city have won a wide reputation for getting to a fire quick, chiefly due to the excellent work of the telephone. There are six engine houses, the chief's residence, and the operating-room of the telephone company on one circuit; one end of the line being grounded at the central office and the other at the engine house farthest away. An individual bell is in circuit at the central office, and one short ring from any of the houses will be answered by the operator. The number of rings on this individual bell always informs the central office which engine house is called. Should any one of the subscribers to the exchange inform the central office of a fire in his neighborhood, the alarm is given the entire department instantaneously, the signal being one long ring. This ring is known by the intelligent horses of the department, and the moment it is heard they spring to their places, beneath the swinging harness—an invention of Chief Hale—and while the men are clasping the harness and getting to their places, one of them, selected for this duty, listens at the telephone while the central-office operator calls out the location and nature of the fire. This is done simultaneously at all the engine houses, and as soon as the man at the telephone gets the desired information, he rushes to the wagon, now ready for the run, and directs where to drive. The advantages of this system are very great. In nearly every case the information from the fire is such that the firemen all know just what will have to be done, and are fully prepared by the time the scene of danger is reached. Instead of having to hunt over an entire block, as is often the case with signal-box alarms, the number of the burning building, as well as which story, is often given by telephone, and each department knows just what will be expected of them, and at what point they must attach their hose. As soon as the alarm is given, the central office notifies the pump-house of the water works company to put on fire-pressure, or rather this is done by one operator while another is giving the alarm to the firemen. The bells in use by the department are all new-style Gilliland, adjusted to ring loud and clear, and the telephone inspectors are instructed to watch them very closely.

Chief Hale, of the department, has had constructed an instrument for cutting electric-light wires in case of fire. It is a large pair of shears, the handles being quite long and insulated, and with a circular basin near the shears, to convey the water that he fears might act as a conductor of the electric fluid, to the interior of the hollow handles, and to the ground. Whenever notified by telephone, the electric-light company is in the habit of promptly turning off the current when a fire is raging near their circuit.

The Pacific Mutual has completed its line from here to St. Louis, and announces, this week, that it is ready for business.

D. B. Macquarrie, who has had immediate charge of the heavy reconstruction of the Kansas City exchange during the past eight months, is a telegraph and telephone man well known in the East. His work for the company here is highly creditable and satisfactory.

There are still some novices in the use of telephones. Some time ago, a big, burly granger walked into the office of Governor McLean, grain inspector of this city, and, on asking, was granted permission to use the telephone. He walked to the instrument, carefully keeping his hands behind him, and, standing about two feet away, called out:

"Hello, Cap.! Say, pard., hello!"

As there was no response, he repeated the call in louder tones; not hearing any reply, he gave a look around, intending to impress the amused spectators with the fact that he knew a thing or two, and said:

"He's not in his office now," and walked to the door, leaving his audience convulsed with laughter. It is to be supposed that he expected the transmitter to open its mouth and talk back.

The board of directors of the Missouri and Kansas and United Telephone companies has issued circulars to the stockholders of both companies, in which the affairs of the companies are shown to be in healthy condition. Since purchasing the property of the United Company the number of subscribers has increased from 500 to 886. Quarterly dividends, the circular announces, will be paid from January 1, 1884. The Missouri and Kansas Company has added 146 subscribers during the last quarter, and new ones are coming in at the rate of about twenty-five per week. The net earnings for the quarter amounted to $7,003.52, but instead of applying this to the payment of dividends, the board decided to use the money in the construction of new lines, and replace it during next quarter from sales of treasury stock.

The exchange at Lawrence, Kan., is to be reconstructed, and work will commence this week. The State University is located there, and its telephone is often busy; conversation being held by pupils with their parents, who reside in Topeka, Leavenworth, Atchison, and Kansas City.

BI-POLAR.

Chesapeake and Potomac Telephone Company.

General Manager Lytle has removed his headquarters from Boston to Washington, and will now devote his entire time to the interests of the Chesapeake and Potomac Telephone Company. He is putting in a new Western Electric multiple switchboard at Boston and Baltimore. A large amount of preliminary construction work has been done by him since assuming charge of the Chesapeake and Potomac Company, we understand, preparatory to connecting new subscribers, which have been rapidly coming in. We predict that the growth of new business in the Chesapeake and Potomac Company's territory will surprise many during the ensuing year.

The Chicago Telephone Company paid an extra dividend of four per cent. This makes sixteen per cent. paid by this company in dividends this year. The stock of this company is quoted at 285.

Since the consolidation of the several district companies into the New England Telephone Company, General Manager Downs has been actively at work in rearranging the consolidated system, and preparing for a great increase in business with the latest improvements in appliances, etc. In Boston, which had less than 2,000 subscribers under the old Telephone Dispatch Company, arrangements are making for an increase of the plant to accommodate from 4,000 to 5,000 subscribers, and in the course of two or three months the latest improvements in apparatus will be introduced, at a cost of $60,000. A South End office will be opened near Tremont and Berkeley Streets, which will provide for 1,000 subscribers, and in that section many people are now waiting for telephone connections. A fine office has been leased, and will be opened next month for this purpose. It is believed that 2,000 subscribers can be added in Boston as soon as the facilities are provided. A telephone exchange has been opened in Young's Hotel, and other branches will soon be opened. At the company's headquarters, 40 Pearl Street, Vice-President Ingham, General Manager Downs, Superintendent Wheeler and Secretary Glidden have their working offices; the Boston district, which includes all the territory formerly covered by the Telephone Dispatch Company and the Suburban Telephone Company, is under the supervision of Col. B. D. Parker, with W. D. McKinney as superintendent of the Boston exchange. A. H. Chapman is superintendent of the trunk lines to the various cities and towns outside the Boston district, and the public using these lines will find convenient offices for the execution of their business. All the executive offices of the New England districts are thus consolidated in Boston, and only the Erie, Union, and one or two small companies controlled by the Lowell syndicate are managed from the former headquarters at Lowell.

There are now 161 cities in Europe where telephones are in use, having a total of 30,066 subscribers. In Asia there are seven, with 420 subscribers; in Africa, four, with 240; in America, 126, with 47,105 subscribers; and in Australia, four, with 897. The average subscribers in America for every town are 378, against 187 in European cities.

It is said that the Mexican Government is interesting itself in the telephone, and building lines for the Mexican Telephone Company without cost to the latter, and at the same time paying a royalty for the instruments used. The earnings are now largely in excess of operating expenses, but the surplus for the present goes into construction. The company is out of debt, and has a working surplus in the treasury.

The Postal Telegraph Scheme.

In behalf of a Government postal telegraph, it is argued that 80 per cent. of the telegraph operations is the transmission of business messages, 8 per cent. in press messages, and 10 per cent. in social messages. The design of the Government telegraph is not to absorb the business messages of the Western Union and other private companies, but to take the so-called "social" messages only. Social messages in Europe, it is said, make up 75 per cent. of all, while in this country the comparatively small proportion would cause little loss to the telegraph companies by their withdrawal. But it may well be asked whether the Government would be justified in organizing the immense machine of a postal telegraph for so small a branch of the telegraph business. The cost of maintaining such an establishment would far outrun the benefits to the public. A Government telegraph cannot be made successful unless it be a complete monopoly, like the Post-Office Department, rigidly excluding all competitors, as is the case with the telegraph in Europe. But such a Government monopoly cannot be established without purchasing the property of private companies at an enormous cost, or entering into an unjust competition to destroy the business of citizens whose capital is invested in the telegraph business. Considerations of prudence and economy will not permit the adoption of the former alternative, and a government of equity and justice cannot adopt the latter.—*Philadelphia Record.*

Annual Meeting of the Mutual Benefit Association.

Over 130 delegates of the United States Telegraphers' Mutual Benefit Association, which is composed of 2,600 telegraph operators, were present, November 22, at a banquet at the Continental Hotel, tendered to them by the Philadelphia telegraphers. These delegates are members of the Annual Convention of the Association, which, before visiting this city, held a meeting in New York. Henry Butler, of Philadelphia, presided at the banquet, and about 150 guests were present. Among them were Chas. H. Tinker, general superintendent of the Western Union Telegraph Company; J. D. Reid, who erected the first telegraph line in Pennsylvania between Harrisburg and Lancaster, and J. E. Zeublin, district superintendent of the Western Union Telegraph Company.

The report of the secretary of the Association shows that there is a reserve fund of $36,000 in the treasury. Upon the death of any member of the Association, his heirs, or whoever he may desire to have it, is paid $1,000. Of the sixteen deaths during the past year fourteen have died from consumption. Clarence Carey was elected president, and A. R. Brewer secretary.

The Electrical Ballet in Vienna.

The latest novelty at the Vienna Electric Exhibition is the electric ballet, the first representation of which, a few days ago, proved a brilliant success. The performance is said to be most entertaining and instructive. "Science," says one authority, "must be danced if it shall influence the great mass of people." That this form of scientific instruction does, indeed, attract the people appears from the fact that all places were taken every time the ballet was performed as soon as the ticket office was opened. The chief features of the entertainment are the introduction of electro-magnets, dynamo machines, telegraph apparatus and telephones, which were dragged on the stage by fantastic goblins, and handled by the graceful danseuses with as much ease as if they were especially trained in the mysteries of electricity. One of the prettiest scenes is the telegraph polka, which is danced by two ladies in the costume of telegraph boys.

An amusing adaptation of the incandescent light has been made at the Bijou Theatre, Boston, in the last act of "Virginia." The two red horns on the devil contain 16 candle lamps, which, being connected with the Edison system in the theatre, are lighted when the devil disappears upward, producing a striking effect.

On Telpherage.*

By Professor Fleeming Jenkin, LL. D., F. R. S.

"The transmission of vehicles by electricity to a distance, independently of any control exercised from the vehicle, I will call Telpherage." These words are quoted from my first patent relating to this subject. The word should, by the ordinary rules of derivation, be telphorage; but as this word sounds badly to my ear, I ventured to adopt such a modified form as constant usage in England for a few centuries might have produced, and I was the more ready to trust to my ear in the matter, because the word telpher relieves us from the confusion which might arise between telephore and telephone, when written.

I have been encouraged to choose telpherage as the subject of my address by the fact that a public exhibition of a telpher line, with trains running on it, will be made this afternoon for the first time.

You are, of course, all aware that electrical railways have been run, and are running with success in several places. Their introduction has been chiefly due to the energy and invention of Messrs. Siemens. I do not doubt of their success and great extension in the future—but when considering the earliest examples of these railways in the spring of last year, it occurred to me that in simply adapting electric motors to the old form of railway and rolling stock, inventors had not gone far enough back. George Stephenson said that the railway and locomotive were two parts of one machine, and the inference seemed to follow that when electric motors were to be employed a new form of road and a new type of train would be desirable.

When using steam, we can produce the power most economically in large engines, and we can control the power most effectually and most cheaply when so produced. A separate steam engine to each carriage, with its own stoker and driver, could not compete with the large locomotive and heavy train; but these imply a strong and costly road and permanent way. No mechanical method of distributing power, so as to pull trains along at a distance from a stationary engine, has been successful on our railways; but now that electricity has given us new and unrivaled means for the distribution of power, the problem requires reconsideration.

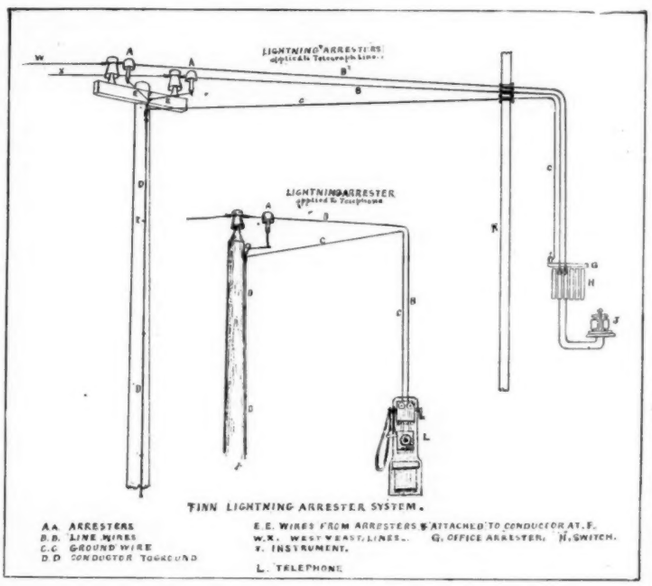
With the help of an electric current as the transmitter of power, we can draw off, as it were, one, two, or three horse-power from a hundred different points of a conductor many miles long, with as much ease as we can obtain 100 or 200 horse-power at any one point. We can cut off the power from any single motor by the mere break of contact between two pieces of metal; we can restore the power by merely letting the two pieces of metal touch; we can make these changes by electro-magnets with the rapidity of thought, and we can deal as we please with each of one hundred motors without sensibly affecting the others. These considerations led me to conclude, in the first place, that when using electricity, we might with advantage subdivide the weight to be carried, distributing the load among many light vehicles following each other in an almost continuous stream, instead of concentrating the load in heavy trains widely spaced, as in our actual railways. The change in the distribution of the load would allow us to adopt a cheap, light form of load. The wide distribution of weight entails many small trains in substitution for a single heavy train; these small trains could not be economically run if a separate driver were required for each. But, as I have already pointed out, electricity not only facilitates the distribution of power, but gives a ready means of controling that power. Our light, continuous stream of trains can, therefore, be worked automatically, or managed independently of any guard or driver accompanying the train—in other words, I could arrange a self-acting block for preventing collisions. Next came the question, what would be the best form of substructure for the new mode of conveyance? Suspended rods or ropes, at a considerable height, appeared to me to have great advantages over any road on the level of the ground; the suspended rods also seemed superior to any stiff form of rail or girder supported at a height. The insulation of ropes with few supports would be easy; they could cross the country with no bridges or earth-works; they would remove the electrical conductor to a safe distance from men and cattle; cheap small rods employed as so many light suspension bridges would support in the aggregate a large weight. Moreover, I consider that a single rod or rail would present great advantages over any double rail system, provided any suitable means could be devised for driving a train along a single track. [Up to that time two conductors had invariably been used.] It also seemed desirable that the metal rod bearing the train should also convey the current driving it. Lines such as I contemplated would not impede cultivation nor interfere with fencing. Ground need not be purchased for their erection. Mere wayleaves would be sufficient, as in the case of telegraphs. My ideas had reached this point in the spring of 1882, and I had devised some means for carrying them into effect when I read the account of the electrical railway exhibited by Professors Ayrton and Perry. In connection with this railway they had contrived means rendering the control of the vehicles independent of the action of the guard or driver: and this absolute block, as they called their system, seemed to me all that was required to enable me at once to carry out my idea of a continuous stream of light, evenly spaced trains, with no drivers or guards. I saw, morever, that the development of the system I had in view would be a severe tax on my time and energy; also that in Edinburgh I was not well placed for pushing snch a scheme, and I had formed a high opinion of the value of the assistance which Professors Ayrton and Perry could give in designs and inventions.

Moved by these considerations, I wrote asking Profesor Ayrton to co-operate in the development of my scheme, and suggesting that he should join with me in taking out my first Telpher patent. It has been found more convenient to keep our several patents distinct, but my letter ultimately led to the formation of the Telpherage Company (limited), in which Professor Ayrton, Professor Perry and I have equal interests. This company owns all our inventions in respect of electric locomotion, and the line shown in action to-day has been erected by this company on the estate of the chairman—Mr. Marlborough R. Pryor, of Weston. Since the summer of last year, and more especially since the formation of the company this spring, much time and thought has been spent in elaborating details. We are still far from the end of our work, and it is highly probable what has been done will change rapidly by a natural process of evolution. Nevertheless, the actual line now working does in all its main features accurately reproduce my first conception, and the general principles I have just laid down will, I think, remain true, however great the change in details may be.

The line at Weston consists of a series of posts, 60 ft apart, with two lines of rods or ropes, supported by crossheads on the posts. Each of these lines carries a train: one in fact is the up line, and the other the down line. Square steel rods, round steel rods, and steel wire ropes are all in course of trial. The round steel rod is my favorite road at present. The line is divided into sections of 120 ft. or two spans, and each section is insulated from its neighbor. The rod or rope is at the post supported by cast-iron saddles, curved in a vertical plane, so as to facilitate the passage of the wheels over the point of support. Each alternate section is insulated from the ground; all the insulated sections are in electrical connection with one another—so are all the uninsulated sections. The train is 120 ft. long—the same length as that of a section. It consists of a series of seven buckets and a locomotive, evenly spaced with ash distance pieces—each bucket will convey, as a useful load, about 2½ cwts., and the bucket or skep, as it has come to be called, weighs, with its load, about 3 cwts. The locomotive also weighs about 3 cwts. The skeps hang below the line from one or from two V wheels, supported by arms which project out sideways so as to clear the supports at the posts; the motor or dynamo on the locomotive is also below the line. It is supported on two broad flat wheels, and is driven by two horizontal gripping wheels; the connection of these with the motor is made by a new kind of frictional gear which I have called nest gear, but which I cannot describe to-day. The motor on the locomotive will give as a maximum 1½ horse-power when so much is needed. A wire connects one pole of the motor with the leading wheel of the train, and a second wire connects the other pole with the trailing wheel; the other wheels are insulated from each other. Thus the train, wherever it stands, bridges a gap separating the insulated from the uninsulated section. Ths insulated sections are supplied with electricity from a dynamo driven by a stationary engine, and [the current passing from the insulated section to the uninsulated section through the motor drives the locomotive. The actual line is quite short, and can only show two trains, one on the up and one on the down line; but with sufficient power at the station any number of trains could be driven in a continuous stream on each line. The appearance is that of a line of buckets running along a single telegraph wire of large size. A block system is devised and partly made, but is not yet erected. It differs from the earlier proposals in having no working parts on the line. This system of propulsion is called by us the Cross Over Parallel Arc. Other systems of supplying the currents, devised both by Professors Ayrton and Perry and myself, will be tried on lines now being erected; but that just described gives good results. The motors employed in the locomotives were invented by Messrs. Ayrton and Perry. They are believed to have the special advantage of giving a larger power for a given weight than any others. One weighing 99 lbs. gave 1½ horse-power in some tests lately made. One weighing 36 lbs. gave 0.41 horse-power.

No scientific experiments have yet been made on the working of the line, and matters are not yet ripe for this—but we know that we can erect a cheap and simple permanent way, which will convey a useful load of say 15 cwts. on every alternate span of 120 feet. This corresponds to 16½ tons per mile, which, running at five miles per hour, would convey 92½ tons of goods per hour. Thus, if we work for 20 hours, the line will convey 1850 tons of goods each way per diem, which seems a very fair performance for an inch rope. The arrangement of the line with only one rod instead of two rails diminishes friction very greatly. The carriages run as light as bicycles. The same peculiarity allows very sharp curves to be taken, but I am without experimental tests as yet of the limit in this respect. Further, we now know that we can insulate the line satisfactorily, even if very high potentials come to be employed. The grip of the locomotive is admirable and almost frictionless, the gear is silent and runs very easily. It is suited for the highest speeds, and this is very necessary, as the motors may, with advantage, run at 2,000 revolutions per minute.

* * * *



FINN LIGHTNING ARRESTER SYSTEM.

Elyria, Ohio, Nov. 15, 1883.

Editor Electrical Review:

I enclose herewith diagram showing the application of my arresters and the method of twisting the ground wire. The two applications are of the simple form.

The ground wires, used with the instruments protected, are in all cases run out and connect with the arrester ground, substantially as shown in the illustration. The copper conductor, held in the arrester shell, is adjusted to within about one-sixteenth of the line; and when the line carries a charge of free electricity of sufficient intensity, it leaves the line at the arrester and passes to the ground by way of the conductor, *D, D.* The philosophy of the operation is this: That free electricity will readily bridge small intervals of space or atmosphere intervening between two conductors, and that in the case of the telephone application the charge is seeking the ground, and will not follow the line into the building, as it would then have to return by way of the instrument ground back to the pole before starting on a direct line to the ground, and the resistance met with in passing from the instrument up the instrument ground against the attraction of the negatively-charged ground is infinitely greater than that offered at the arrester. Free electricity attracted to the ground will, in its passage to the ground, follow the line of least resistance, and will not only to a limited extent retrace its course, and go contrary to the force that attracts it to the ground.

In the case of the telegraph application, the free electricity may or may not go to the ground. If attracted to the ground, it will go there by the same route as that in the telephone; but if it is seeking a negative cloud field beyond the building, it will remain on the lines, and pass from one line to the other by way of the arresters and their connections, *E, E.* That is, if it comes from the West, and is seeking the East, it will pass from the west line to the east line and on eastward. This is often the case in thunder-showers, and by the prevailing way of protecting lines the electricity is forced to enter the building. In the use of my system the electricity is not forced to enter the building in any case, and will not do so unless superior conducting paths are offered for it in the building, which should in all cases be avoided.

Now, if there are any very great errors in this arrangement or system, I should be pleased to have you indicate them, as I feel that you will be ready to see them from the constant practice you, no doubt, have in similar fields.

Very respectfully yours,

J. L. Finn.

* Introductory address delivered to the Class of Engineering, University of Edinburgh, October 30, 1883.

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NEW YORK, DECEMBER 6, 1883.

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A New Occupation for the Army.

We read with much interest the account which came to us from Washington regarding the so-called successful test made with telegraph and telephone wires under ground.

As no human being on either hemisphere with a knowledge of the subject has ever said that the thing was impossible, we hope the originators of this scheme will not permit themselves to fall into an ecstacy over their success. The public is not, to any extent, interested in scientific successes, restricting itself to the adoption only of commercial successes.

If these distinguished army engineers had shown that a long line of telephone could be operated under ground efficiently and economically, they would be warranted in mounting the nearest hill and blowing their horns to the seven winds. They have not done this, and there is not the least probability that they ever will. They have succeeded simply in proving to their own satisfaction what no one has ever pretended to doubt, and the best thing for them to do now is to retire to the sanctity of their quarters, collect their mileage, and rest their overtaxed minds.

The treasury department, says a report, has been successfully connected under ground with the other departments by telephone. When we heard this we at once looked up the latest report of the Honorable Secretary of the Treasury. In this we found that the surplus for the last fiscal year was over one hundred and fifty millions of dollars. This encourages us to believe that the treasury department can stand the "racket," to use a slang but expressive phrase. But the trouble with the public is that it has not always a surplus of one hundred and fifty millions of dollars to draw upon, and hence the underground telephone, even if a success from a scientific stand-point which has by no means been proved, could not be made popular.

What gave us most pleasure in the report made by these eminent military gentlemen, was that, though they mentioned nearly all the different governmental departments as being connected under ground by telephone, the Patent Office was excepted. Those tire some people that infest the purlieus of the Patent Office have long been flooding the cables over the earth and those in the waters under the earth, with their inexplicable conundrums, and it is at least a melancholy satisfaction to know that they are not to be permitted to infest the very earth beneath our feet.

It will strike the average intellect as somewhat strange that the engineer officers of the army should be employed in making useless experiments in underground telephony, while our forts and defenses are crumbling to pieces from neglect. One-half the energy that has been displayed in showing that the United States Treasury was rich enough to support an underground line of telephone, would have served to brace up that tottering relic of bygone ages, Castle William, in New York Harbor, or added a new engine to the sloop-of-war Powhattan, which now, in an ordinary breeze of wind can hardly keep out of her own way.

This conversion of the officers of the army into cave diggers would be unconstitutional if it were not too ridiculous to be treated seriously; and furnishes additional reasons why the arms should be reduced to one man with a cork leg.

Physics in General Education.

It is difficult to conceive of a sadder picture than that of a man wailing over the condition of his fellow man. Mark Twain wept over the grave of Adam, and Byron was moved epigrammatically at the sight of the tomb of Lord Castlereagh, but from altogether different motives. Each, however, blended eulogy with condemnation. But there is a species of human being whose grief over the sins of his fellows bears such an emphasis that our only regret is that he is compelled to remain any longer in their contaminating society. He resembles a certain type of minister, thoroughly honest no doubt, in his convictions, who groans audibly as he looks us over as we sit before him. In his estimation, there is no help in us. We are lost irrevocably; and the more he assures us of the hopelessness of our case, the more unnecessary seems the employment of a minister for the sole purpose of assuring us of our final condemnation. There is a class of scientists here in America, which, instead of laboring diligently in their vocation, waste their time in fruitless lamentation over the present condition of science, and the future out-look. Like the child who finds with dismay that her doll is stuffed with sawdust, they have lost confidence in the world about them, and refuse to be comforted.

Quite recently, a paper was read before the Association for the Advancement of Science, wherein its author, Professor Mendenhall, dwelt at great length upon the lack of physical studies in industrial and other training in America, as well as the dearth of original investigation. The paper is an interesting one; and had he stopped right here and told us how all this could be remedied, it would have been a model of excellence. But no. The meeting being in Montreal, he assures the Canadians, that in their country, unlike America, by which, no doubt, he meant the United States, instruction and investigation go hand in hand. Now, we do not remember of hearing of any very important discoveries in pure science having been made by the Canadian faculty, nor are we aware that the prospects of technical instruction are more hopeful there than here in the States. We do remember hearing of some original discoveries having been made in meteorology by one Professor Wiggins, but, unless we are seriously in error, these discoveries proved to be more original than accurate.

But, it was when treating of the lack of physical schooling in the United States at the present time, that Professor Mendenhall was most eloquent. Inferentially there was no hope for us here, and those who heard his paper must have been much surprised when, upon crossing the border and entering the United States, they found the machine shops and the laboratories still running, just as if their owners had not heard the professor's paper, and were, therefore, unaware of the fate that awaited them.

To be serious, let us see what are the facts regarding the future instruction of the American youth in the trades. Having made a careful survey of the subject, we are enabled to say, without the fear of contradiction by those who are informed, that the facts of the case point to a condition directly the reverse of that pictured in the interesting but somewhat inaccurate paper of Prof. Mendenhall. Let him inquire in the big shops, and he will be told that the prospects of general technical education were never so bright as now; that the skilled mechanics of Europe, trained in industrial schools of high order, no longer monopolize the best work in American shops, but are finding native competitors at the bench. Up to a quite recent period, it has been the custom here for young men, after receiving a common school education, to serve an apprenticeship at the bench and call themselves skilled artisans, though they knew not the theory of their trade. But now the splendid field for mechanical work, which has opened in this country, has encouraged many young men to learn the theory of their trade before beginning the practical work, and we have seen university graduates don the blouse and take up the hammer.

Already we have a number of schools organized on the plan of the European industrial schools, such as that in the Cooper Institute, the Troy School, Institute of Technology in Boston, and the Sheffield School. But these, since a tuition fee is exacted, have not been found to be the best type of school for a republic like this, and the germ of a great industrial system has been started in the city of New York, where the poorest lad may receive a common school and a technical education without money and without price.

This school has four hundred pupils, and is now six years old. It is situated in West Fifty-fourth Street, and is conducted under the auspices of the Society of Ethical Culture.

Progress has been defined as that amount of advancement which can be corroborated by statistics or fact. This being the case, let us investigate the degree of proficiency attained by the lads of the two upper forms of the school, when they have reached the age at which the novices of the European school begin their indu-trial education. This may not unreasonably be looked upon under the rule as a fair exponent of progress made. A boy of the second form learns to draw a helix, to apply the helix in the construction and drawing of a square-threaded screw, to draw bolt with hexagonal head, to draw bolt with nut on threaded end, to draw bolt when threads are indicated, to make free-hand sketch of slide valve of shop engine and make finished drawing of sketch, to make free-hand and also finished sketch of back cylinder head of shop engine with sectional view through the axis; free-hand sketch of front cylinder-head of engine with stuffing-box and finally finished working drawing of same; to sketch and make drawing of crank of engine; to sketch and make drawing of cross-head of engine. He is exercised in green sand moulding, being provided with moulder's tools, flask and loam. (In casting, liquid plaster-paris is used.) He learns to mould, and make castings of cone and truncated cone; to make moulds and castings of quadrangular and truncated pyramid; to make moulds and castings of oblique and rectangular parallelopipeds; to make moulds and castings of cylinder; of hollow cylinder, to introduce moulding of special forms; to make mould and casting of slide-valve of steam engine and explain functions and operation of same and other parts of engine; to make moulds and casting of back cylinder head of shop engine; to mould and make casting of stuffing-box of front head of steam cylinder; to mould and make casting of crank of engine; to mould and cast cylinder of a small engine. (The pupil always makes his own core.)

The first-form boy learns to sketch and make drawing of connecting-rod of engine; to sketch and make drawing of piston of engine, showing a portion of the piston-rod and the method of fastening to the piston; to sketch and make drawing of eccentric of engine; eccentric strap of shop-engine; eccentric rod of steam engine; of fly-wheel of engine; of steam cylinder of shop engine; to make a sketch and complete working drawing of cylinder with heads, piston and piston-rods in place.

Vise work is introduced early in the course, and later on instruction is given in the hand-turning of brass. For the vise work, vises, hammers, cold chisels, files, center punches and squares are provided. The wood lathes are used for brass turning. The first-form boy learns to chip pieces of cast-iron to a straight line; to chip a bevel and a groove in a piece of cast-iron (the cape chisel is here introduced); to make a cube from rough pieces of cast iron, first by chipping nearly to required size, and then finishing with file; to chip and file hexagonal prism from piece of composition metal (a template is used in gauging the faces to the proper angles); to chip and file a rectangular prism from piece of wrought iron; to chip and file square hole in a piece of cast iron into which a rectangular piece must be fitted; hand turning of brass; (turning a piece of brass to a true cylinder, regardless of size) turning cylindrical pieces of brass of specified diameters to turn from a stick of brass a number of knobs and acorns, such as would be used in the oil-holes of a machine; making a thread with a die and milling and finishing head; to explain the outside and inside chaser in threads; drilling brass with twist drill and boring with hand-tool; to construct a small horizontal engine. In this latter work the pupil makes his own patterns and castings and finishes the parts according to the drawing he makes as a preliminary to the construction.

The pupil has explained to him by practical illustration, and is later on examined upon the most important properties of matter,

as impenetrability, divisibility, porosity, compressibility, elasticity, ductility, malleability and cohesion. Then he learns the principles of inertia; of the parallelogram of forces; how a single force may be resolved into two; the composition of parallel forces; (the pupils construct the graduated levers). Witnesses experiments illustrating the attraction of gravity by falling bodies; illustrating the use of levers and the law of moments; experiments with the wheel and axle, inclined plane, wedge and screw. He is taught how to determine the centre of gravity of different forms, and also how to construct simple apparatus with which to illustrate the three conditions of equilibrium, indifferent, stable and unstable; how to determine the specific gravity of different substances; in determining the laws of the action of gravity upon falling bodies; the use of the pendulum and how to determine the laws of vibration by experiments. He assists in experiments with Blackburn's compound pendulum, and is given practical explanations of the principle of momentum, of the laws of action and reaction, of the action and laws of centrifugal force; of the laws of friction.

In hydrostatics and hydraulics he witnesses and takes an active part in experiments with liquids, as regards the varying pressures of different depths and the flow from an orifice; experiments with the overshot water wheel, which he must construct himself. Next comes: weight of air and laws governing its compression; atmospheric pressure in mercurial column; principle of suction and its application; action of the siphon. In sound: vibration; reflection. In heat: temperatures; effect of heat upon various bodies; latent heat of fusion; variation of boiling-point by pressure; conductivity of metal; Davy's safety lamp and its theory; feeble conductivity of water; mechanical equivalent of heat and Joule's theories. In light: its propagation in straight lines; intensity and the laws governing it; comparing lights by the intensity of their shadows; reflection of light; refraction of light in passing from one transparent medium to another; direction taken by a beam of light passing through a prism; composition of a beam of solar light as shown by the spectrum; convex and concave lenses; colors and their various combinations; refraction and total reflection. Construction and use of solar microscope. In electricity and magnetism: natural and frictional electricity; electrical conductivity of various substances; the magnet and its properties; dipping of the magnetic needle; the galvanic battery; decomposition of water by electric current; experiments with oxygen, hydrogen, &c.

In all these experiments the little workmen take a hand; where apparatus not of really complicated construction is required, they make it themselves.

Nor is it expected that all will comprehend the experiments with equal readiness. On the contrary, the experiments are frequently repeated in order that the slow ones may have an opportunity to catch up with their comrades.

The instruction in physics is not permitted to interfere in any way with the instruction in the other branches of a regular school course which is going on all the time.

Without attempting to give an opinion upon the ultimate success of this system of technical education, it may be said that the growth of the school in which it is in practical running order, has been, to say the least, extraordinary; the more so since it is founded upon principles to a certain extent the reverse of those in vogue elsewhere in the industrial school. Six years ago it was opened with eight scholars, six boys and two girls, whose parents had been encouraged to enter them.

Gas that Contaminates the Atmosphere.

In a recent number of the REVIEW we commented upon the backwardness of sanitary science. Dr. Hamilton, a careful observer, in a recent paper read before a scientific association, declared that sanitary science was so little understood that no man could decide as to the healthfulness of a house or locality. It was mere conjecture. Even when the pipes and drains seem to be in the most perfect order, a house will be infected with a something which seriously affects those who dwell in it. This being the case, Dr. Hamilton says if he were about to build a dwelling house, he would have a separate building adjacent to the main structure, in which all the pipes and drains should be located. Thus, he thinks, he would be able to defy those maladies which it is alleged are propagated where defective drains and sewers exist.

No one will deny that this is a sound deduction warranted by the assumed premises. The trouble is, however, that these premises are incomplete; therefore the conclusion is erroneous, and hence the removal of the sewers and drains and water and sink pipes from the dwelling would not necessarily insure its healthfulness.

Prof. Pettenkofer has made a series of careful observations, which assure him that coal gas, when leaking into the ground, produces the direst results on those who dwell in the vicinity of the leakage. In other words, you may test all your sewers, drains, and pipes, and find everything in apparent good order, yet are the fatal germs of death creeping silently and unobserved into your dwelling. The escape of gas in a house can be readily and at once detected by its peculiar odor, but it is otherwise when the escape takes place in the ground from breakage of the mains, whence it finds its way into the basements of houses. The evil effects of such escape, says the *Lancet*, commenting upon the paper, have been exemplified in Italy, in Cologne and Breslau, and Prof. Pettenkofer believes that such cases are far more frequent than is generally supposed.

The poisonous properties of coal gas depend upon the amount of carbonic oxide which it contains. This is ten per cent. in coal gas, and many times more in what is known as water gas. The other constituents, although irrespirable, do not act as direct poisons.

From Grube's researches, says the *Lancet*, it is evident that the danger of coal gas depends not so much upon long exposure to a mixture of air and carbonic oxide, as upon the amount of the latter contained in the air. Air containing a proportion of five parts of carbonic oxide in 10,000 can be breathed for hours and even days by men and animals without any injury to health, whilst a proportion of seven or eight in 10,000 causes appreciable discomfort; if twenty in 10,000, difficulty of breathing, weakness and uncertainty of gait; twice that proportion leads to stupefaction, and higher proportions to extreme and fatal effects, referable to the nervous system. The occurrence of cases of illness directly attributed to the entrance of gas into houses from the mains has been found to increase in the winter months, a fact partly explained by the more frequent breakage of the pipes in that season, and also, perhaps, by the closing of windows and artificial heating of rooms inviting the accumulation and entrance of the gas from without.

Gas thus filtered through the soil may be quite odorless, at any rate until it has collected in large amount, and herein, says Prof. Pettenkofer, lies the danger to the dwellers in the basement of a house.

On the earliest occurrence of symptoms, such as headache, the windows should be thrown open, and if, on their closure, the symptoms reappear, it may be suspected that there is an escape of gas near the house. The mains should be examined, and the defects repaired without delay.

Prof. Pettenkofer urges that the police should be instructed to warn all the inhabitants of all the houses in the vicinity to keep their rooms well ventilated. When gas remains in the soil, says he, it may again find its way into houses where the rooms are artificially heated in the cold season.

The subject which Prof. Pettenkofer treats is of such grave importance that it is somewhat remarkable that our so-called sanitary engineers have not yet looked into it, even if it ever occurred to them, which is very doubtful.

We have seen a house - and, doubtless, our experience is by no means unique—which a professional sanitary engineer had declared to be in perfect order, and yet its occupants —or at least some of them—suffered with the symptoms of malaria whenever they lodged within its walls for an extended period.

This is good evidence to sustain the assertion of Dr. Hamilton that we know little about sanitary science, and there is reason to believe that the so-called sanitary engineers, whether or not connected with the Board of Health, can do little more than correct abuses which are visible to the eye, or which may be detected by the nose; but so far as the conditions which go to make up the necessary hygienic precautions that insure an untainted, uncontaminated atmosphere is concerned, they are all at sea.

Protection from Lightning.

Singularly enough, lightning-rods, though of the greatest importance, have received but little attention from electricians up to a quite recent period. It seems to have been taken for granted that the question of lightning protection was settled long ago, but experiment has shown that this is by no means the case. Instances have been given in the REVIEW of cases where a certain class of lightning-rods, when suddenly called upon to serve their purpose, have proved lamentably incompetent, and where those who have been to much pains and no little expense to secure what was regarded as a sure protection from vagrant lightning, discover, when too late, that the confidence which they had set upon their rod system was misplaced.

It is only recently, too, that the subject of lightning protection has received much attention on the other side of the water. A committee, representing several societies interested in the subject, which was appointed some time ago to inquire into the best method of adjusting and constructing lightning-rods, has recently made a most valuable report, based upon all the information it was possible to procure

Inasmuch as sharp points, even if made of platinum, are liable to be melted and blunted, the report recommends that the rod should preserve its full diameter nearly to the extremity, and be merely beveled off. To preserve the sharp point, for drawing off the silent discharges of electricity, the attachment of a copper ring, bearing three or four needles of suitable size, at a distance of about a foot below the extreme top of the rod, is suggested.

Vanes, finials, and other ornamental iron work on the upper part of a building, must be metallically connected with the conductor. A coronal, consisting of a copper band, with stout copper points, each a foot long, at intervals of two or three feet on its circumference, is recommended for the chimneys of factories. Copper is preferred to iron as the material for rods, chiefly because it is less liable to be injured and rendered inefficient by rust. The diameter should be three-eighths for copper rods, half an inch for copper rope, and nine-tenths of an inch for iron rods. The rods should not be insulated from the building, but should be attached to it by fastenings of the same metal as the rod itself. A good earth connection is, of course, specially important.

In towns, connection with the iron water and gas mains is recommended, but not with the lead pipes, because they are too liable to be melted.

As a general rule, the lower end of the conductor should be soldered to a plate of the same metal as itself, having an area of not less than a square yard, while the hole in which this plate is sunk must be so deep that the earth surrounding the plate shall be moist even in the driest weather.

Drains and water courses may be utilized for keeping the plate in connection with a large extent of moist earth. It is recommended that the height of the rod be such that a cone having its vertex at the upper terminal, and its sides sloping at forty-five degrees, shall inclose the whole building, or as much of it as this particular rod is required to protect.

Must the Wires Come Down?

THE HON. W. M. EVARTS SAYS "NO" IN A SENTENCE ONE HUNDRED AND FIFTY-TWO WORDS LONG—OTHER VIEWS.

Our esteemed contemporary the *Sun*, says that the Hon. William Maxwell Evarts attained his promised 6,000 candle-power intensity of earnestness in arguing against the claim of property owners in West Twenty-fifth street, that the Brush light poles and wires are an objectionable and dangerous nuisance and ought to be taken down. Mr. Evarts came into Judge Ingraham's court at 12½ o'clock. He wore his strikingly magnificent satin lined and embroidered overcoat and his tall black beaver. His hands were empty, but Lawyer C. C. Beaman, his associate, tramped at his heels, lugging satchels crammed full of law and red tape. Lawyer Beaman piled law books on the long black table before Judge Ingraham's mahogany desk. Mr. Evarts slowly assumed the perpendicular before this bulwark of calfskin, got his right forefinger into working order, adjusted his gold eyeglasses, and began to pile up clouds of sentences and waft them toward the Judge.

Mr. Evarts remarked at the outset that the Aldermen had the right to regulate the streets, and have electricity for light if they thought they needed it. The Twenty-fifth street affair was a structure that conformed completely with the permit. It was not the part of a private citizen anyway to correct irregularities in the structure or the exercise of the authority to use electricity. That was the duty of the city alone.

Lawyer Beaman stroked his moustache complacently, and watched his associate admiringly as he uttered this sentiment. The Hon. Lucius Eugene Chittenden, however, sprang to his feet and paraded nervously on the court-room carpet with fire in his eye. The Hon. Mr. Evarts went on to say that the placing of electric light poles, telegraph poles, telephone poles, gaslight poles, awning poles, flag poles, barber poles, Russian Poles, and policemen on the streets was clearly within the power of the local authorities. He shook his fist at his honor and said:

"Nobody, nobody that I ever heard of before, has ever contended that the faculty of communicating light to the streets, through their whole extent, by whatever means, were pertinent to their construction, are not included in the dominion over the streets that is acquired by the Corporation of the City of New York, under any of the various forms of domination or of dedication either under the old acts or under the recent act—I say I have never heard it disputed that the city of New York had the right to light the streets, when opened to the public use by due process of law, to enter upon and occupy them with such structures as were suited to that purpose, and so far as the question of authority goes, the discretion as to the mode of occupation of the streets for that purpose is allowed to be in the Common Council."

Mr. Evarts drew a long breath, folded his arms, and paused to note the effect of his remark on the Court. The audience gazed anxiously toward the bench with the same motive. His Honor leaned over weakly upon his right elbow, and let his head drop upon his hand. Mr. Evarts observed this, and reduced the strength of the current of his remarks;

"Presumptively the method of street lighting above the ground. No man lighteth a candle and putteth it under a bushel."

Finally, Mr. Evarts assured his Honor that he could not properly grant any injunction against the Brush poles in Twenty-fifth street or award any damages for their presence or operation there. Then he shut off the current and sat down with a good-natured smile.

"I think we need a recess, don't we?" inquired the Court.

When the lawyers came back the Hon.

Lucius Eugene Chittenden had his innings, and talked steadily for some hours at the Court. Mr. Chittenden planted one foot on a cane-bottomed chair, took a brief from Delancey Nicoll, his associate, and began by thundering:

"The time has come when the rights of the various corporations which are erecting the electric structures and structures like them ought to be judicially ascertained. The city is suffering, as no city probably ever suffered before, from the consequences of long toleration of this invasion of private rights. It is a professional luxury equal to that of sitting down to a good dinner to turn back to a decision and see in what brief, convincing, and comprehensive terms the wrong of such invasions is disposed of. The decision is very short, and I will read it."

Mr. Chittenden read steadily for eight minutes, while his Honor's eyes were closed in a dreamy reverie, and the Hon. Mr. Evarts gazed steadily out of the window and fondled the satin lining of his overcoat.

Mr. Chittenden continued to talk and read with great power. He threw up both hands, and then brought down one with resounding emphasis upon his pile of law books, saying:

"We maintain that nothing has given authority to the Common Council to authorize or the defendants to erect, the aerial lighting structure. It is almost unnecessary to say that that Twenty-fifth street structure is utterly, completely, and absolutely unnecessary for electric lighting of the streets. It is built in the parsimony of a corporation to save the expense of a proper structure. There is no other European, Indian, Hindoo, Chinese, Chinook, Kanuck, Kanaka, Egyptian, Arabic, or Patagonian city that would permit the defacement of its fairest streets by an offensive structure, carrying death and destruction and ruin to life, limb, and property. There is no other city on the face of the globe where such a thing is not absolutely prohibited by law."

Judge Ingraham made some remarks that proved that he had heard, noted, and understood everything that both lawyers had talked and read at him. He wasn't strong enough, however, to give his decision. That he reserved until the thunder clouds of law could be swept away by the court-house cleaners.

The Thomson-Houston System.

This enterprising company have moved into their new factory, at Lynn, Mass., and are now finally settled and in good working shape. The demand for their dynamos and electrical appliances has forced them to run their works three nights a week. Among the recent shipments made and orders received by this company are: an additional 25-light machine for the local company at Lynn, which increases the plant in that city to one hundred and twenty-five lights, of which the city authorities have ordered twenty for street-lighting purposes.

They are fitting up a central station for the New Haven Electric Company. It will consist of two Armington & Sims engines; four 25-light dynamo machines; one hundred lamps, and the best insulated fire-proof wire, will be used throughout. The plant will be built in the most thorough manner, and will be in operation at an early day.

The New Bedford Electric Light Company have ordered a 50-light plant, and will be fitted up in the same general way as the one at New Haven. A syndicate have formed a company in St. Louis, and will put in a 100-light plant at once, using this system of lighting. An additional fifty lamps have been added to their plant at Syracuse, N. Y., making a total of one hundred lights in operation in the great salt metropolis.

The Jacksonville Hotel company have recently ordered twelve lamps for the St. James Hotel, at Jacksonville, Fla. Council Bluffs, Iowa, have a 25-light plant. In New Britain, Conn., the Stanly Tack Works have taken a 12-light plant, and P. & F. Corbin recently increased the number of their lamps from twelve to twenty-five.

As a result of their exhibition at Cincinnati, this company have sold a 25-light machine and lamps to the Russell & Morgan Printing Company, of Cincinnati.

The Electrical Exhibition.

INSTRUCTIONS FROM THE TREASURY DEPARTMENT RELATIVE TO THE ADMISSION OF ARTICLES.

A Washington dispatch says that Secretary Folger has issued a circular to Collectors of Customs and others relative to the exhibition of electrical apparatus, &c., to be held at Philadelphia by the Franklin Institute, in which he directs that invoices of all articles imported for exhibition shall recite the fact that the goods embraced therein are intended for the exhibition, and that each shipper shall be required to make his invoice in triplicate, giving a description of his goods, their value, and the marks and numbers thereon; but any number of such invoices may be embraced in one declaration by the agent, such declaration to be taken before a consular officer of the United States, and certified to in the usual manner.

Articles intended for this exhibition, and arriving at the ports of Boston, New York, Baltimore, San Francisco, or New Orleans, or any port on the Canadian frontier at which goods may be shipped for immediate transportation under the act of June 10, 1880, may be shipped by bonded common carriers from the port of first arrival to Philadelphia. Such of the instruments of precision as may require verification and adjustment for adaptation to the scientific purposes of the exhibition in advance of its opening, may be delivered to the Franklin Institute for such preliminary adaptation upon receipts signed by the president or vice-president of the Institute.

Electric Lighting in Lewiston, Me.

A local company has been formed at Lewiston, which will become a branch of the Consolidated Electric Lighting Company of Maine. The officers are as follows:

President—E. F. Packard.
Vice-President—Ara Cushman.
Treasurer—Frank W. Parker.
Manager—H. N. Wagg.

Among the directors are E. F. Packard, President First National Bank; Ara Cushman, President Shoe and Leather National Bank; C. I. Barker, agent of the Bates Corporation; Hon. George E. Wing, Judge of Probate; Frank W. Parker, Treasurer Androscoggin County Savings Bank; R. C. Reynolds, President of the City Council, and Alderman H. N. Wagg.

A station will be built with the capacity for 200 to 300 lights.

The increase of productive power of blast furnaces in this country is shown by the following facts: In 1831, forty years after the first one was established in Pennsylvania, one furnace produced 1,100 tons of pig iron, and the output was considered quite remarkable. In 1865 an average of 150 tons per week or 7,800 tons a year, was considered large. In 1875 the output per month reached 2,800 tons, or 700 tons per week; and in 1881 one furnace produced at the rate of 1397.5 tons per week, or 5,590 tons per month.

Telegraphing Along Wire Fences.

MILWAUKEE, Dec. 1.—An experimental work has been going on for a short time along the Milwaukee and St. Paul Railroad Branch and the Brandon Branch, about 30 miles in length, the object being to determine whether or not the barbed wire of the fence on either side of the road can be utilized for telegraphic purposes. The fence wire was placed in proper condition for a sufficient distance to make a satisfactory test, the wire being run under the surface at road crossings. Superintendent of Telegraph Simpson returned from the scene of the experiment yesterday, and decides that the plan is not practicable. Telegraph work can be done over the fence wire at this time, he says, but during the winter months, when huge snow banks completely cover the fence, the line would be made useless. There are thousands of miles of wire fence along the Western lines, and it has been contended that they should be utilized for this purpose.

The American Electric and Illuminating Company Recovers their Rights in Providence.

At the regular meeting of the Board of Alderman, held on Nov. 28th, Alderman Burnham asked to call up the petition of the American Electric and Illuminating Company, and presented the following report of the committee appointed to investigate the matter:

The joint special committee to which by resolution No. 446 (C. S.), approved Nov. 7, 1883, was referred the petition of the American Electric and Illuminating Company, a corporation organized under the laws of the State of Maine, report that as required by Chapter CCIV. (city ordinances) notice of a public hearing on said subject was published in the city newspapers, and at the appointed time the petitioners appeared with counsel, as did also the Rhode Island Electric Lighting Company. Both parties were fully heard, the Rhode Island Electric Lighting Company being the sole remonstrant. The petitioners presented evidence satisfactory to your committee that they are, as claimed in their petition, "competent and ready to do business," that theirs is a genuine and legitimate business enterprise, and one in which a large number of our own citizens and business men are interested, many as stockholders, and many as parties desiring to use the light to be furnished by the petitioners. They also presented satisfactory evidence as to the high estimation in which their light is held in cities where it is used. Your committee is satisfied that these petitioners are responsible for any debts or damages for which they may become liable, they having a large visible property in this city, and also an agent or attorney, long resident here, whose name is a sufficient guarantee for the good faith of any enterprise with which he may be connected.

The committee recommends that the prayer of the petition be granted; the petitioners to give bond to indemnify the city against damages resulting to it thereby. A bill for an ordinance is herewith presented, the passage of which is recommended by the committee:

For the committee:
GEORGE H. BURNHAM,
Chairman.

A request signed by about 100 of our leading business men, asking that the petition be granted, was read, as was also the report of the chief engineer of the fire department. At the same time Mr. Burnham presented an ordinance granting the American Electric and Illuminating Company permission to erect poles and wires, and to use the poles of the Rhode Island Electric Light Company, paying them a suitable compensation for the same; also ordering them to have an attorney here upon whom any process could be served, and to give a bond to secure the city for any damages or losses.

Mr. Brennan wished the matter laid over to the next meeting, and moved to that effect, but Mr. Burnham said the company wished to get to work, and the citizens wished the lights as soon as possible, so Brennan's motion was lost.

The ordinance was then passed.

In the recent large fire at Savannah, Ga., the Brush electric light station was destroyed. The same will be in running order by January 1st. Two 10x12 Ball engines of Erie, Pa., will furnish the power.

Telephone Stock Quotations.

American Bell Telephone Company.....194
Central New York Telephone and Telegraph Company.....103
Empire State Telephone and Telegraph Company.....205
Hudson River Telephone and Telegraph Company.....105
New York and New Jersey Telephone Company..... 85
Mexican Telephone Company..... 3⅞
New York and Pennsylvania Telephone Company..... 80
Southern Bell Telephone and Telegraph Company.....130
Tropical Telephone Company..... 2½
Central Union Telephone Company.....100
Iowa Union " " 100
Missouri and Kansas Telephone Co..... 90
United Telephone Company (Kansas and Missouri)..... 89
Bell Telephone Company, of Missouri...165
Wisconsin Telephone Company.....125
Cumberland Telephone Company.....100
Great Southern Telephone Company....100
Michigan Telephone Company..... 105
Chicago Telephone Company.....285
Erie Telephone Company..... 59
Union Telephone Company.....100
Southern New England Telephone Company.....178
New England Telephone Company..... 74

NEW PATENTS—ELECTRICAL—1883.

INDEX OF INVENTIONS FOR WHICH LETTERS PATENT OF THE UNITED STATES WERE GRANTED IN THE WEEK ENDING NOVEMBER 27, 1883.

288,971 Switch for electric lamps; George T. Benson, New York, N. Y., assignor to John S. Kelso, Jr., Stamford, Conn.

289,008 Automatic circuit breaker for railroad signals; Malcolm W. Long, Hyde Park, Mass.

289,092 Electric cable; William Halkyard, Providence, R. I., assignor of one-half to Henry A. Church, same place.

289,164 Electrical cable; Samuel D. Strohm, Philadelphia, Pa.

289,165 Electrical cable; Samuel D. Strohm, Philadelphia, Pa.

289,166 Electrical cable; Samuel D. Strohm, Philadelphia, Pa

289,173 Chemical telegraph; Theodore F. Taylor, Brooklyn, N. Y.

289,178 Telephone switch; James Tregurtha, Malden; assignor by mesne assignments to the Adjustable Telephone Support Company, Boston, Mass.

289,179 Support for telephones; James Tregurtha, Malden, assignor by mesne assignments to the Adjustable Telephone Support Company, Boston, Mass.

289,180 Support for telephones; James Tregurtha, Malden, assignor by mesne assignments to the Adjustable Telephone Support Company, Boston, Mass.

289,197 Safety cut-out for electro-magnetic motors; Edward Weston, Newark, N. J., assignor to the United States Electric Lighting Company, New York, N. Y.

289,198 Apparatus for regulating and controlling the electrical transmission of power; Edward Weston, Newark, N. J., assignor to the United States Electric Lighting Company, New York, N. Y.

289,199 Electric circuit breaker, Edward Weston, Newark, N. J., assignor to the United States Electric Lighting Company, New York, N. Y.

289,200 Dynamo or magneto-electric machine; Edward Weston, Newark, N. J., assignor to the United States Electric Lighting Company, New York, N. Y.

289,233 Hotel and burglar-alarm annunciator; William S. Corwin, Esq., Newark, N. J.

289,285 Telegraphic relay and repeater; James A. Maloney, Washington, D. C., assignor of one-half to Glen W. Cooper, same place.

289,301 Relay for quadruplex telegraphs; Henry C. Nicholson, Kenton, Ky.

289,309 Speaking telephone; James H. Robertson, Brooklyn, N. Y.

289,320 Telegraph pole; Samuel T. Suit, Suitland, Md.

289,321 Telephone switch; James Tregurtha, Malden, assignor by mesne assignments to the Adjustable Telephone Support Company, Boston, Mass.

289,324 System of generating and regulating electric currents; Edward Weston, Newark, N. J., assignor to the United States Electric Lighting Company, New York, N. Y.

289,325 Regulator for dynamo or magneto-electric machines; Edward Weston, Newark, N. J., assignor to the United States Electric Lighting Company, New York, N. Y.

289,326 Regulator for electrical generators; Edward Weston, Newark, N. J., assignor to the United States Electric Lighting Company, New York, N. Y.

289,327 Apparatus for treating carbon conductors; Edward Weston, Newark, N. J., assignor to the United States Electric Lighting Company, New York, N. Y.

289,328 Apparatus for charging and discharging, secondary batteries; Edward Weston, Newark, N. J., and Leonard E. Curtis, New York, N. Y.

289,353 Telephone switch; Charles T. Loring

Boston, Mass., assignor by mesne assignments to the Adjustable Telephone Support Company, same place.

BUSINESS NOTICES.

Notice to Purchasers and Users of Electric Gas-Lighting Apparatus.

We have already given public notice, by our circular of October 25th, 1883, that we had revoked our contract with the Electrical Supply Company of Ansonia, Connecticut, for good and sufficient reasons. We meant what we said; and again notify all purchasers or users of electric gas-lighting apparatus, manufactured and sold by that company, under any pretended right, or color of right, claimed to be conferred by our said contract of October 20th, 1883, that we *shall* hold them responsible as infringers of our patents, and *shall* prosecute them as such infringers.

Parties buying goods of us, or our authorized agents, *will be* protected by us. Inviting the fullest investigation as to our rights, we are respectfully

THE ELECTRIC GAS LIGHTING COMPANY.
By Louis W. Burnham,
President.

No. 45 Milk St., Boston,
December 3, 1883.

Rhode Island Telephone and Electric Co.

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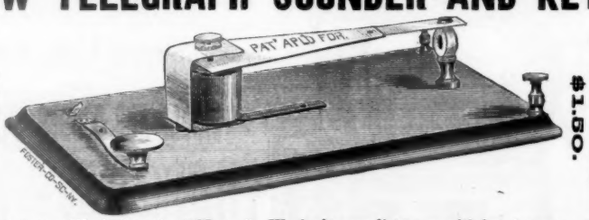

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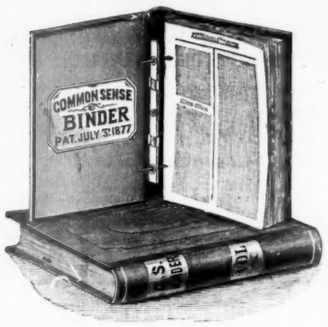

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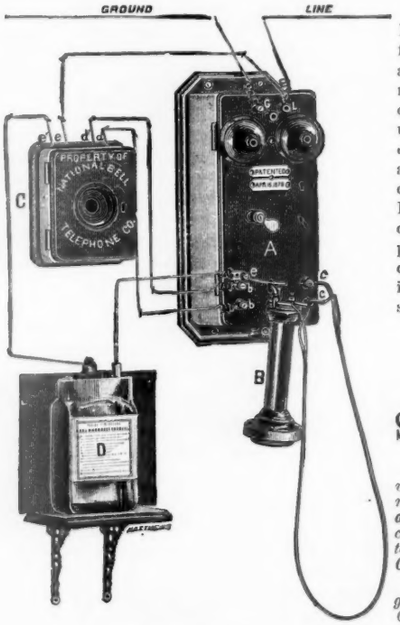

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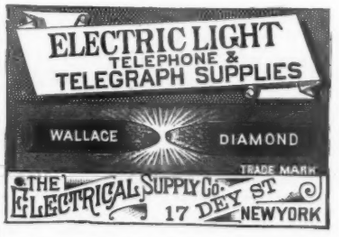

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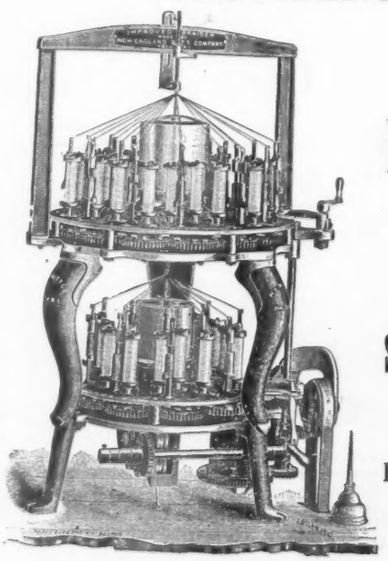

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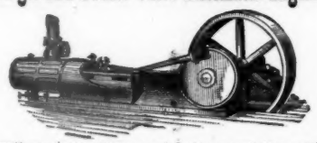

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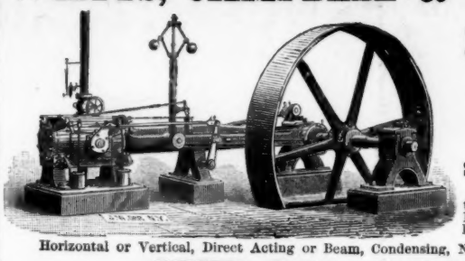

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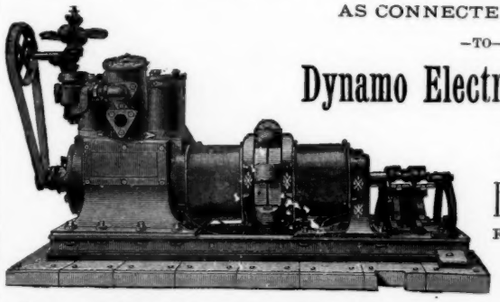

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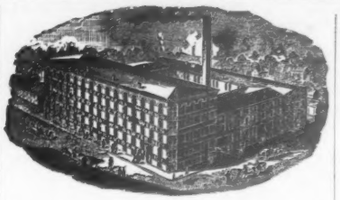

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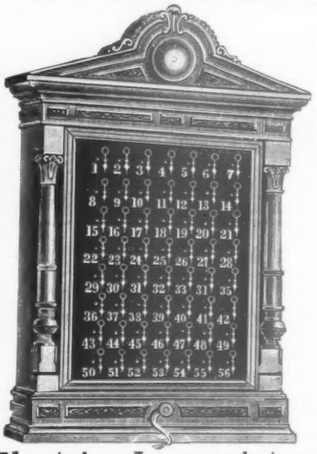

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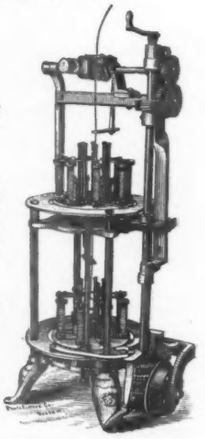

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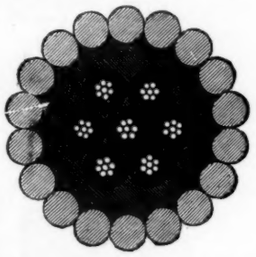

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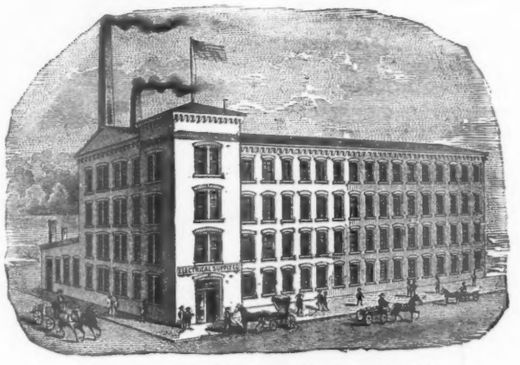

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